



ON THE CLIMB
AUSTRALIA PLOTS
PATH TO AIR FORCE
OF THE FUTURE
SHOW REPORT P20

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link to death of pilot **10**

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FLIGHT

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COMMERCIAL ENGINES

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COVER IMAGE

This Rolls-Royce Trent XWB front bearing housing is set to be the largest engine component built with additive layer manufacturing techniques to fly **P35**



BEHIND THE HEADLINES

Asia Editor **Greg Waldron** met up with our contributor **Emma Kelly** at the **Avalon** air show in Australia (P20). And for our **commercial engines** report, Editor **Murdo Morrison** visited **Rolls-Royce** in Derby, while **MTU** hosted **Michael Gubisch** in Munich (P30)



NEXT WEEK MALAYSIA

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Delta set to add more 717s to fleet **P16**. Further F-16 upgrades heading Lockheed Martin's way **P25**



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IMAGE OF THE WEEK

Pilatus has rolled out the 100th PC-21 from its Stans facility, with the Royal Saudi Air Force aircraft also the 1,000th turboprop trainer it has built, along with the PC-7/Mk II and PC-9 range. Qatar, Singapore, Switzerland and the United Arab Emirates are also current operators of the new-generation PC-21.

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Pilatus

THE WEEK IN NUMBERS

1,560

CFM International

Number of CFM56 turbofan engines delivered in 2014 by CFM International partners GE Aviation and Snecma

\$5bn

Flightglobal dashboard

Amount spent on US Federal Aviation Administration's NextGen satellite-based air traffic modernisation effort

40%

Flightglobal dashboard

Percentage of the search area for missing Malaysia Airlines flight MH370 covered as of 25 February; some 24,000km²

QUESTION OF THE WEEK

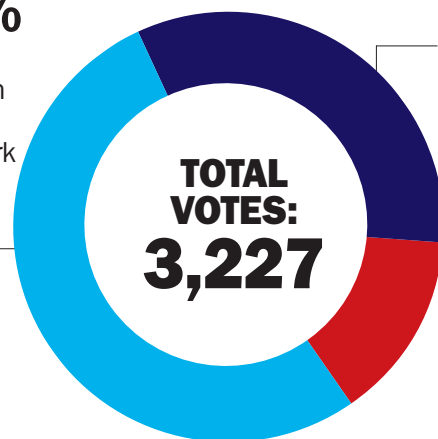
Last week, we asked: **Will success in Egypt help Dassault complete sale of Rafale to India?** You said:

53%

Yes, it's just down to final paperwork

33%

It will never get signed off



14%

It will stall for a year or more

This week, we ask: **Will Lockheed Martin hit its \$80 million F-35A price target by 2019?**

- ☐ Not enough orders to achieve economies of scale
- ☐ No, but unit price will fall below \$100 million
- ☐ Yes – development risk is low and orders are picking up

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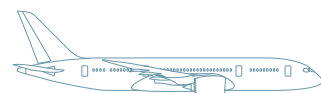
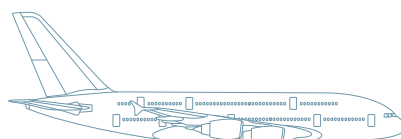
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Question of thrust

Emirates wants to fly it, Rolls-Royce wants to power it – but would the Airbus leadership be right to jump aboard the bandwagon calling for a re-engined A380neo programme?

Slightly more than a decade ago, it was Boeing's turn to make a hard decision. Airbus had launched the A380, so the company weighed up whether to respond with a clean-sheet design or a simpler product revamp.

Boeing decided that the safer bet was to install a new engine and a composite wing on the 747, focus on the air cargo market and hope to pick off a few orders from the European superjumbo.

If Boeing had to make that decision all over again today, a hindsight-empowered executive team might select a third option: walk away, and leave the disappearing A380 market alone to its rival.

Airbus certainly now fears no competitive threat to the A380 in the very large aircraft segment. Instead of attacking the competitor's product, Boeing's 777-9X appears designed to strip any remaining demand for the passenger-carrying 747-8 Intercontinental, which – barring a massive swing in fortunes for the air cargo market – may not survive in production beyond 2020.

The very large aircraft market is not large enough to merit another euro of investment

Airbus's commercial aircraft executives today remain devoted to the A380 they helped deliver to the market in 2007, saying – despite the aircraft's slower than expected sales, higher than projected costs and lack of a new generation of carbonfibre-based composites – the type will be re-engined. How the corporate leadership at the company perceives the wisdom of an A380neo programme is less clear.

There are plenty of reasons to think that a business case is feasible. Airlines have shown a bottomless ap-



The right time to improve a classic?

petite for re-engined aircraft. A 10% improvement in fuel efficiency – provided by a new engine and minor aerodynamic tweaks – appears enough to seal as many as 100 new orders from the A380's largest customer, Emirates. And if there is a financial risk, it is of little concern to Airbus, because in a re-engining programme, the majority of the development cost is borne by the engine manufacturer. In Rolls-Royce, Airbus has a supplier that seems motivated and eager to accept that risk.

As a near-consensus of market analysts have pointed out, however, that is still not enough to justify launching the programme. In their view, the A380 has demonstrated that the very large aircraft market segment is not large enough to merit another euro of investment.

It will soon be the turn of Airbus leaders to make a fateful decision. With no competitive threat coming from Boeing and no clear sign of demand, doing nothing is the only option they would have no reason to regret after one more decade. ■

See Special Report P31

Cutting it fine

Privatising public services is not a new concept, but selling off a nation's coastal and inland helicopter search and rescue (SAR) operation is a bold move.

The process of transferring the UK's SAR provision from the military has rarely been an edifying one, however. It has seen a contract awarded then cancelled amid a criminal investigation; the surprise rejection of one bidder; and a whiff of told-you-so, job-protecting inevitability about the selection of one helicopter type.

Bristow Helicopters' contract will commence on 1 April. It is the first time the company has embarked on a SAR operation of this scale, and it sees the 10-year award as a showcase. Get this one right, and similar deals will materialise across the globe.

But it has not been all plain sailing. AgustaWestland, one of the two airframers involved, has delivered its AW189 late, and it is an entirely unproven platform in the role. The site of one base covering the southeastern coast of England remains undecided, months before it should go live. And there are grumblings over the pay being offered to those transferring from the military.

Some of this can be dismissed as teething troubles, but whatever it takes, Bristow has to be ready.

The waters around the UK and its upland areas are as unforgiving as its media, and should there be a whiff of private sector incompetence about a bungled rescue the company will face unparalleled public scrutiny. ■

See This Week P8



For up-to-the-minute coverage of the A380 and other commercial aviation projects, sign up at: flightglobal.com/dashboard



BRIEFING

AERCAP REMOVES NINE AIRCRAFT FROM RUSSIA

LEASING Operating lessor AerCap terminated leases on six Boeing 757s and three 767s with Russian carriers in December 2014. The lessor says the aircraft were “accessed and removed within 72h with minimal loss, and are all now under letters of intent to be leased or sold”. Its net exposure to Russia totals \$2.2 billion, at an appraised value of \$2.8 billion, based on the average of half-life market values from Flightglobal consultancy Ascend, BK Associates and AISI.

AIRBRIDGE TO EXPAND WITH 737 AND 747-8F

CARGO Russian freight operator AirBridgeCargo is aiming to acquire another Boeing 747-8F this year, and introduce a 737-400 freighter. AirBridge's fleet comprises 14 747s, including six Fs, but the carrier says it is reinforcing its capacity to expand to new destinations, such as Los Angeles. Parent company Volga-Dnepr Group is purchasing the 737-400SF from Aviation Capital Group, the cargo carrier has disclosed in its internal publication.

VIP TREATMENT FOR THAI ARMY HELICOPTERS

ORDER Airbus Helicopters has received a contract to equip the Royal Thai Army with six VIP-roled EC145 T2s, with first deliveries to occur during 2016. The service – which last year introduced eight AS550s from the same manufacturer and has six US-built UH-72A Lakotas on order – will use the Turbomeca Arriel 2E-engined light twins for “official passenger transportation duties”.

AER LINGUS REVISES A350 DELIVERY DATES

SCHEDULE Aer Lingus has agreed a revised delivery schedule with Airbus for the delivery of nine A350s, with the first aircraft now set to arrive in 2018. The Irish flag carrier will now receive its nine A350s in batches of three per year between 2018 and 2020. Dublin-based Aer Lingus had initially expected the deliveries to take place between 2015 and 2018. Any possibility of the carrier ordering A330neos is now “off the table”, it says.

LOCKHEED IMPROVES FURY UAV DESIGN

UNMANNED SYSTEMS Lockheed Martin has tweaked the design of the flying wing-shaped Fury unmanned air vehicle, as it pursues contracts from US special operations forces and the international market for the 15h-endurance type. The Block 10 update of the Fury adds a wider-chord and longer-span airfoil to increase endurance, especially when being flown at low speeds, while the centre wingbox design for the 136kg (300lb)-class UAV also has been amended to make it easier to integrate new and heavier sensors.

VIKING DELIVERY TO SERVE FIJI RESORT

PURCHASE Sydney-based Walker Corporation has ordered a float-equipped DHC-6 Twin Otter Series 400 aircraft from Viking Air of Canada via Australasia sales representative Utility Air, for operation on guest transport services at a new resort in Fiji. The 19-seat twin-turboprop will be delivered in the second quarter of this year.

BOMBARDIER POLL AMENDMENT

CORRECTION Our Question of the Week item in last week's issue (*Flight International*, 24 February-2 March) featured incorrect data. Your response to the issue “Can Bombardier turn things around?” was in fact: Yes, it's on the right path – 41%; Only with the help of a major new investor – 39%; and No, it is in too deep a mess – 20%. Our apologies for this oversight.



Operations at Humberside will commence on 1 April using S-92s

ROTORCRAFT DOMINIC PERRY HUMBERSIDE AIRPORT

Bristow gets set for SAR handover

First of five new search and rescue bases is unveiled as operator prepares to take over function from RAF and navy

Bristow Helicopters has unveiled the first of five new bases it is constructing as it begins the transition to managing search and rescue (SAR) operations on behalf of the UK government.

Two initial sites – at Humberside airport and Inverness – will go live on 1 April, when they will take over from Royal Air Force Westland Sea King HAR3/3A crews located in Leconfield and Lossiemouth.

Speaking at the opening of the Humberside facility on 26 February, Jonathan Baliff, chief executive of Bristow Group, said he was “excited but humble” about the challenge ahead. He paid tribute to the RAF and Royal Navy crews who have performed the role for the last 70 years, noting that Bristow “will be blessed” if it achieves those levels of service.

However, the £1.6 billion (\$2.5 billion), 10-year contract still has several issues to resolve. Operations at Inverness will commence using Sikorsky S-92s, rather than AgustaWestland AW189s as intended, due to delays in certifying the latter's SAR variant.

Baliff describes AgustaWestland as “a very good partner” in how it is “working through the issues we have with them”. Two SAR-roled AW189s have been de-

livered so far, although only one is presently being used for training.

Two further AW189 bases are due to come on stream later this year, but Baliff declines to comment on a future delivery schedule. Samantha Willenbacher, UK SAR director at Bristow, says its team is still completing operational evaluations of the AW189 and “once it is ready” will introduced it at Inverness. However, she is unable to provide a timeline for that transition.

Other bases may begin operating smaller AW139s when they go live later this year. So far, Bristow has received two SAR-configured examples under a long-standing contingency plan with the manufacturer.

Meanwhile, Willenbacher says an announcement will be made “shortly” regarding its plan for a base in the southeast of England. This has been in disarray since the closure of Manston airport last year. Another site has been secured, which will begin “work-up” from 1 April and go live as scheduled on 1 July.

Bristow's crews at Humberside, meanwhile, have been conducting familiarisation and training from the facility since January and now have a pair of new Sikorsky S-92s. ■



BA, CAA 'must act'
on cabin air toxins
THIS WEEK P10

RECORD ATTEMPT STEPHEN TRIMBLE LONDON

Solar Impulse 2 completes warm-up

Only days before launching a historic, round-the-world flight, the Solar Impulse 2 staged a 12h test flight on 26 February from Abu Dhabi.

The single-seat craft is now poised to begin the first solar-powered circumnavigation of the Earth, with 25 flight days spread over about five months and 12 stops.

Solar Impulse 2 pilot Andre Borschberg completed the training flight with a staged go-around of the Abu Dhabi International airport, finally landing shortly after 21:00 on Runway 31.

"We are really getting close to our [round-the-world] adventure," says Bertrand Piccard, founder of Solar Impulse.

The mostly low-altitude flight over the capital of the United Arab Emirates was coordinated from a control centre in Monaco and by a locally-based ground crew.



The aircraft is set to circumnavigate the Earth using solar power

Borschberg and fellow pilot Piccard are preparing for a journey not unlike the 1986 non-stop, nine-day circumnavigation of the globe by Voyager pilots Dick Rutan and Jeana Yeager.

Unlike the Voyager's fuelled, non-stop flight, the Solar Impulse 2 will not carry any fuel and will

make several stops. However, Borschberg and Piccard will complete multiple flights lasting more than five days in an unpresurised and unheated cockpit.

More than 17,200 solar cells across a 72m (236ft) wingspan will feed electric power to four 17.5hp engines driving propellers. ■

AVIONICS
DAN PARSONS WASHINGTON DC

Brazil's Gripens get wider view with AEL pact

Saab has selected Brazil-based AEL Systems to provide wide-area and head-up displays for Gripen NG fighters being purchased by the Brazilian military.

Brazil became the first confirmed export customer for the NG model in October 2014, when it ordered 28 single-seat and eight two-seat aircraft for its FX-2 programme. The selection process for a company to produce the cockpit displays began in January, Saab says.

Development and delivery of the Gripen NG avionics will take four years and includes integration and production work in Brazil by Elbit Systems-owned AEL.

Saab will perform system integration with the airframe in partnership with Brazilian aerospace company Embraer. ■

CONTRACT CRAIG HOYLE LONDON

Enhanced Typhoon gains Brimstone 2

Eurofighter programme nations agree multi-role upgrade package including MBDA air-to-surface missile for Royal Air Force

The four Eurofighter programme nations have signed a roughly €200 million (\$224 million) contract for a Phase 3 capability enhancement (P3E) package, intended to strengthen the type's multi-role credentials.

Although signed on the behalf of Germany, Italy, Spain and the UK, one of the main elements of the work will be the full integration of the MBDA Brimstone 2 air-to-surface missile for the latter's Royal Air Force. This activity will be worth £72 million (\$111 million) to Eurofighter partner company BAE Systems, which completed a feasibility trial linked to the enhancement late last year.

"The Brimstone 2 close air support weapon will further enhance Typhoon's effectiveness, enabling it to deploy the precision-guided weapon against high-speed, manoeuvring surface targets with

low collateral damage," the UK Ministry of Defence says.

Other elements of the P3E package include avionics upgrades, improvements to the Eurofighter's mission system and maintenance equipment and capability enhancements related to its use of other weapons. These include MBDA's Meteor beyond visual-range air-to-air missile and standoff-range Storm Shadow cruise missile.

Full integration of the Brimstone 2 will enable the Typhoon to carry six of the weapons, which will be integrated using a pair of three-round launchers. The P3E standard is scheduled for delivery during 2017, with the upgrade "expected to be delivered into RAF service in late 2018," the MoD says.

"Support for the contract will come from all four core nations,

and the enhancement package will benefit all who use it," says Eurofighter chief executive Alberto Gutierrez.

The Eurofighter consortium, which signed the P3E contract with the nations via the NATO

Eurofighter and Tornado Management Agency at the IDEX show in Abu Dhabi on 22 March, says definition phase work is already under way for the programme's subsequent Phase 4 capability enhancement effort. ■



BAE Systems will integrate the new close air support weapon



SAFETY DAVID LEARMOUNT LONDON

BA, CAA 'must act' on cabin air toxins

Coroner calls for action in response to pilot autopsy showing presence of damaging compounds also found in aircraft

The UK Civil Aviation Authority and British Airways have been given until 13 April to reply to a coroner's "Report to Prevent Future Deaths", that the December 2012 death of a 43-year-old BA pilot, Richard Westgate, was associated with the presence in his body of organophosphate toxins that are present in aircraft cabin air.

The report makes a series of statements about the presence of toxins in cabin air and their potential effects on occupants, and demands statements from both organisations about what they intend to do to prevent further deaths.

The Senior Coroner for the County of Dorset has advised BA and the CAA of his "matters of concern". These include: "That organophosphate compounds are present in cabin air; that the occupants of aircraft cabins are exposed to organophosphate compounds with consequential damage to their health; that impairment of the health of those controlling the aircraft may lead to the death of occupants; there is no real-time monitoring to detect such compounds

in cabin air; [and] that no account is taken of genetic variation in the human species, such as would render individuals tolerant or intolerant of such exposure.

"Urgent action should be taken to prevent future deaths and I believe your organisation has the power to take such action," the coroner tells BA and the CAA. He also says it is in his power to demand that they supply, within the

HEALTH

Pilot-turned-doctor pins performance degradation on fumes

At least 3% of airline pilots are flying with degraded physical and mental performance caused by repeated exposure to neurotoxins in aircraft cabin air, and could become incapacitated during flight if their exposure continues, the Global Cabin Air Quality Executive heard during its annual conference in London on 25 February.

The assessment was presented by Dr Michel Mulder, a former KLM airline captain and medical doctor who now specialises in helping pilots whose health have been damaged by their work. A KLM internal



The carrier has been given a deadline of 13 April for its response

response time, details of action they intend to take to counter the organophosphate threat to passenger and crew health, or to justify their intent not to take action.

"We will respond to the coroner in due course. It would be inappropriate to comment further while proceedings are continuing," says BA. ■

HELICOPTERS DAN PARSONS WASHINGTON DC

Second JetRanger X takes off to follow the leader



Approval and service-entry of the Bell 505 are set for 2016

Bell Helicopter has performed the maiden sortie of its second 505 JetRanger X flight-test vehicle from Mirabel, Canada.

The aircraft joins an initial flying prototype which took to the skies in November last year and has since been used for a first batch of certification testing, including autorotation trials.

"This puts us one step closer to certification and production," says David Smith, programme director for the JetRanger X. "The [second] aircraft performed incredibly well, successfully dem-

onstrating a low-speed traffic pattern at 60kt [110km/h]."

Launched at the Paris air show in 2013, the Turbomeca Arrius 2R-engined Jet Ranger X is seen as a direct competitor to the Robinson Helicopter R66. The 505 has had 300 letters of intent from potential customers, and approval and service entry are scheduled for 2016.

"We continue to make excellent progress with the flight-test programme and are working to assess key operational scenarios customers may face," Smith says. ■

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NPAS was launched in 2012 to replace localised air support units

BUDGET KATE SARSFIELD LONDON

Police air service cuts fall on bases

Revenue reduction also forces NPAS in England and Wales to replace four helicopters with 'cheaper-to-fly' fixed-wing aircraft

The National Police Air Service (NPAS) of England and Wales will close 10 bases over the next two years, following a hefty cut to its budget. The publicly funded service will eventually operate 23 aircraft from 15 strategically located sites.

Four helicopters will be replaced by the same number of fixed-wing aircraft, "as they are cheaper to fly", says NPAS.

Ian Whitehouse, accountable manager for the service, says NPAS needs to find "substantial financial savings" as it faces a 14% cut in revenue over the next three years.

"It has not been an easy decision to move to a 15-base model," adds Mark Burns-Williamson, chairman of the NPAS strategic board. "These are the sort of diffi-

cult decisions that have to be taken with the economic climate we are all operating in."

NPAS was launched in 2012 to replace localised police air support units with a centrally funded, borderless operation. The intention was to drive down the costs of police air support by £15 million (\$24 million) a year.

The bases set to close are Durham Tees Valley, Halfpenny Green, Rhuddlan, Sheffield and Warton in the north of England; Husbands Bosworth and Ripley in central England; Pembrey in Wales; and Wattisham and Lip-pitts Hill in the south of England. New bases are planned at Elstree, near London, and at East Midlands airport, where the four new fixed-wing aircraft will be based. ■

ORDNANCE CRAIG HOYLE LONDON DAN PARSONS WASHINGTON DC

Future RAAF F-35s lined up for Kongsberg missile

The Australian and Norwegian defence ministries have strengthened their relationship on the latter's in-development Kongsberg Joint Strike Missile (JSM), boosting the chances of Canberra acquiring the weapon for its future fleet of Lockheed Martin F-35s.

Under an expanded agreement discussed at the Avalon air show near Melbourne, the ministries will work together to investigate the potential of both air forces acquiring the weapon.

"Norway and Australia have maintained a close dialogue for several years regarding the JSM within the framework of the multinational F-35 partnership," Norway's defence ministry says. "This agreement takes the process one step further, with Australia agreeing to provide expertise in missile control and guidance systems."

Designed for internal and external carriage by the F-35, the JSM will be suitable for use as an anti-ship and land-attack missile. Oslo expects the combination to achieve operational readiness "in the early 2020s".

Separately, the Royal Australian Air Force has demonstrated a wing kit for the Boeing joint direct attack munition which triples the effective range of the weapon when released from a Boeing F/A-18 Hornet. The wing kit was shown to increase the 227kg (500lb) weapon's range from 13nm (24km) to 39nm, during releases conducted from up to 40,000ft above the Woomera test range in South Australia.

Boeing will produce and integrate the wing kits for the service under a contract awarded in 2011, with initial deliveries planned for later this year. ■



Kongsberg

The Lightning II is able to carry the JSM internally or externally

AEROMEDICAL EMMA KELLY MELBOURNE

Toll orders AW139s, prepares training in Australia

Australian transportation group Toll has ordered eight AgustaWestland AW139s, to deliver part of a 10-year aeromedical contract with the New South Wales (NSW) government. Toll also will build and operate the country's first training centre authorised by the manufacturer.

Late last year, Toll and NSW Helicopter Rescue Service – the latter operating as the Westpac Life Saver Rescue Helicopter

Service – were named as preferred bidders for the state's new Helicopter Retrieval Network, which will also serve the Australian Capital Territory.

The service will operate from 2017, with the operators to respectively cover the southern and northern regions.

Toll's order was signed at last week's Avalon air show near Melbourne, where Westpac also announced that it will obtain four

AW139s from Lease Corporation International.

The new training centre will be at Sydney's Bankstown airport, and will be made available for other AgustaWestland customers in Australia and New Zealand.

The site will house a CAE 3000-series Level D full-flight motion simulator, an advanced underwater escape training facility and wet and dry winching practice towers. It could also be

upgraded to support future models such as the AW169 and AW189, says David Jackson, chief executive of Toll's resources and government logistics division.

Lease Corporation International also announced an agreement at the show to provide Australian Helicopters with six AW139s, to be delivered from later this year for use on behalf of Air Ambulance Victoria. ■

See Show Report P20



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ELECTRONICS STEPHEN TRIMBLE LONDON

BAE to provide 777X fly-by-wire REUs

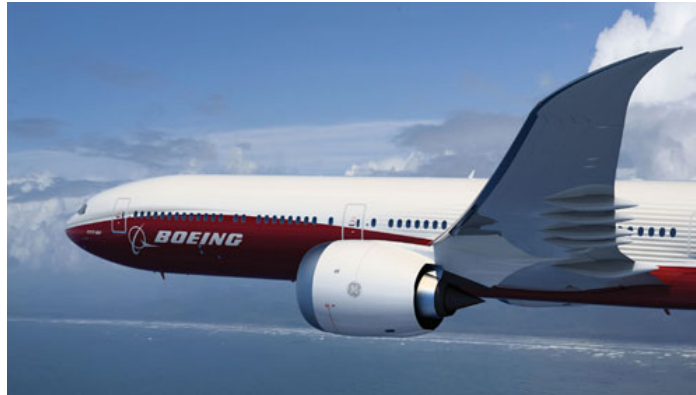
Boeing announces supplier of improved remote electronic units for revamped widebody's in-development onboard systems

Boeing has decided the supplier for the final piece of the revamped fly-by-wire and flight control system currently in development for the 777X aircraft family, announcing on 24 February that it has selected BAE Systems to provide the system's remote electronic units (REUs).

The 400-seat 777-9X and longer-range 777-8X will come equipped with 43 REUs spread out along the wings and empennage of each aircraft, says Andy Corea, director of air transport systems for BAE.

Boeing primarily focused on installing a newer engine – the GE Aviation GE9X – and a longer-span, composite wing derived from the 787 programme when it launched the 777X family.

Under the skin of the 777X, however, are a number of innovations – including the REUs – that bring the onboard systems and flightdeck in alignment with sev-



The updated aircraft features a decentralised control architecture

eral of the key technologies introduced with the 787.

Besides one major architectural difference – the 777X will draw systems power from bleed air rather than 787-style onboard electrical generators – Boeing's two newest widebodies will share very similar flight controls.

The original 777 family, including the in-production

777-300ER, 777-200LR and 777F, uses a centralised control system by which a computer sends commands by wire to actuators powering each of the individual control surfaces, such as the aileron, elevator or rudder.

The 787 programme decentralised this architecture, with REUs placed alongside or near the control surfaces that each commands.

This layout reduces weight by shortening the length of cabling required to connect the flight control surface to the electronic unit that delivers commands, Corea says. By selecting BAE, Boeing has decided to switch suppliers for the REUs between the 787 and 777X family, he adds.

BAE's sales pitch to Boeing for the 777X contract emphasised the company's legacy of providing electronic control systems for GE Aviation engines, Corea says. These systems must operate in "extreme environments" of temperature and vibration at very high levels of reliability, he adds.

New aircraft development programmes offer opportunities for the supply chain to come forward with their product innovations. For the 777X, BAE developed "advanced packaging techniques" for the REUs that improve reliability while reducing size, weight and cost, Corea says. ■

SUPPLY AARON CHONG SINGAPORE

Boeing forges 737 deal with India's Bharat

Boeing has signed a multi-year contract with Bharat Forge to supply titanium forgings for wing components for the Boeing 737 and 737 Max.

The Indian metal company will supply pre-machined forgings from its facilities in Pune and Baranasi to Boeing in the first quarter of 2016. These will then be installed at the airframer's assembly plant in Renton, Washington.

Boeing says the contract reinforces its strategy to expand its forging supply base. Boeing's vice president and general manager of supplier management Kent Fisher adds that such partnerships reduce risk and bring new players into its supply chain to ensure capacity and competitive cost. ■

PRODUCTION STEPHEN TRIMBLE LONDON

P&W upgrades A320neo engine line

Pratt & Whitney has installed a horizontal engine assembly moving line at the factory dedicated to building the PurePower PW1100G-JM turbofan for the Airbus A320neo family.

The US-based manufacturer formally unveiled the renovated facility on 25 February as a key piece in its \$1 billion investment plan designed to meet escalating commercial engine production rates for the all-new engine.

The horizontal assembly method is expected to boost production capacity inside the factory. The system can take an engine assembly and raise it vertically or rotate it. P&W also has made the system programmable, so the movement on the assembly line can be automatically adjusted depending on the rate of demand.

P&W expects that engine production at the Middletown,

Connecticut, facility could double by 2020. The same factory also assembles the International Aero Engines V2500 engine, one of two powerplant choices available for the current A320 family.

The PW1100G-JM competes against the CFM International-

Leap-1A to power the A320neo family. Versions of the same PurePower-branded engine core power a range of aircraft still in development or testing, including the Bombardier CSeries, Embraer E-Jet E2, Irkut MC-21 and the Mitsubishi Regional Jet. ■



PW1100G-JM engine production is expected to double by 2020



**Key Airbus supplier
primed for further
A320 ramp-ups**
AIR TRANSPORT P16

FLEET AARON CHONG SINGAPORE

Mihin Lanka cancels its Boeing order for A320s

Mihin Lanka says it has cancelled its earlier order for two Boeing 737-800s in favour of more Airbus aircraft.

The airline's head of commercial, Rohana Perera, tells Flightglobal it will instead lease up to three Airbus A320 family aircraft – two A320neos and one A319 – from Air Lease Corporation (ALC). Its deal for the two 737s was also inked with ALC.

Perera, however, declines to comment on why the carrier decided against the 737s.

Flightglobal's Ascend Fleets database shows that Mihin Lanka currently operates a fleet of three aircraft, comprising of one A320 and two A321s.

SriLankan Airlines told Flightglobal last year that Mihin Lanka will switch to an all-Boeing fleet so that the group will have a "balanced strategy", with SriLankan remaining an Airbus operator.

The two airlines are also in talks to merge into a single carrier, awaiting approval from the government. ■



Boeing

ACQUISITION

Air Austral claims two Terrible Teens

Air Austral has claimed two "Terrible Teens" – early-model Boeing 787-8s that have struggled to find buyers. The Indian Ocean carrier is planning to operate the 787s from Reunion to Bangkok and Mayotte to Paris.

LIBERALISATION JON HEMMERDINGER WASHINGTON DC

Southwest CEO joins Open Skies row

Gary Kelly adds his voice to carriers opposed to "subsidised" Middle Eastern operators' expansion into the US market

The boss of Southwest Airlines has jumped into a growing row with Middle Eastern carriers, saying those fast-growing airlines pose an increasingly potent threat to carriers in Europe and the USA.

"Subsidies to Middle Eastern carriers, worldwide, is a huge question," chief executive Gary Kelly told members of Baltimore's business community during a breakfast near Baltimore/Washington International Thurgood Marshall airport on 20 February. "We need a level playing field, and I feel our trade representatives would feel the same way."

His comments come as major US network carriers continue an assault against Middle East airlines, which they say unfairly benefit from government subsidies. Those carriers have expanded into the USA thanks to Open Skies agreements. Kelly says Southwest is closely following the debate just as the Dallas-based carrier expands overseas.

The event in Baltimore came weeks before Southwest begins service from that city to San Jose, Costa Rica. The carrier also plans to add flights from Houston to Latin America and the Caribbean.

"Open Skies are important. We are just now getting started with international service," says Kelly. "We do not want to be faced with subsidised competition."

The three US network carriers American Airlines, Delta Air Lines and United Airlines have alleged in recent months that billions of dollars in subsidies

allow carriers like Qatar Airways, Emirates and Etihad Airways to sell seats at artificially low fares. The Gulf carriers have denied the allegations.

The US industry want regulators to limit those carriers' expansion and prohibit them from flying US-European routes, allowed under current agreements.

The controversy has gained attention as the Gulf carriers, known for having a premium product, have expanded their fleets and added new flights to European and North American destinations, offering customers in those regions the ability to connect at Middle East hubs to destinations further east. ■

SAFETY MAVIS TOH SINGAPORE

Overdue hydraulics checks ground 128 Boeing 737-800s

Southwest Airlines has grounded a fifth of its fleet after identifying an overdue maintenance check required on the aircraft's standby hydraulic system.

The 128 affected Boeing

737-700s were found to have overflowed a required check. A standby system serves as a back-up to the jet's primary hydraulic systems.

In a statement, Southwest says that once it identified the problem, it

"immediately and voluntarily removed the affected aircraft from service, initiated maintenance checks, disclosed the matter to the US Federal Aviation Administration, and developed an action plan to complete all overdue checks".

The grounding caused the cancellation of about 80 flights. Southwest says the FAA has subsequently approved a proposal that allows the airline to continue operating the aircraft for a maximum of five days as the checks are completed.

"The safety of our customers and employees remains our highest priority and we are working to resolve the situation," the carrier adds. ■



AirPhotomedia

The carrier voluntarily removed the affected aircraft from service



POWERPLANTS DAVID KAMINSKI-MORROW & STEPHEN TRIMBLE LONDON

Key Airbus supplier primed for further A320 ramp-ups

Safran chief backs another rate rise despite growing workload, while lauding Leap success

Airbus engine supplier Safran believes current demand for narrowbody aircraft justifies a further increase in production of the A320 family to 50 per month within a few years, even as the supply chain transitions to a new model at the same time.

"It looks like the market is there," says Jean Paul Herteman, chief executive of Safran, which includes Snecma. "We would be ready to supply it."

As one half of the CFM International consortium with GE Aviation, Snecma supplies the low-pressure sections for the CFM56 engines powering A320s and 737s, as well as the Leap-1-series engines in testing for the A320neo and 737 Max.

Both aircraft types are being delivered at a rate of 42 per month, but the pace will grow sharply over the next four years. As the A320 rate rises to 46 per month in the second quarter of next year, Boeing plans to deliver 47 every month in 2017. So far, Airbus has not responded to Boeing's announcement last October that 737 production will again rise to 52 per month in 2018.



CFM's Leap engine made its first flight on GE Aviation's 747 testbed

Herteman, however, says Snecma will be ready to play its role in the ramp-up if Airbus decides to escalate yet again.

Raising production at the same time that Airbus transitions to the re-engined A320neo and Boeing introduces the 737 Max will be a challenge, he adds. But "it's the type of issue you'd like to have".

Safran delivered 1,560 CFM56 engines last year, an increase of 58, as its full-year propulsion revenues rose by 7.4% to €8.2 billion (\$9.2 billion).

It says its civil propulsion activity was "particularly strong" as growth forecasts in the airline in-

dustry drove investments. It took new orders for 1,527 CFM56 and 2,717 Leap engines last year.

The Leap is an "outstanding commercial success", with total orders for 8,500 engines, Herteman says. He claims this gives the company a 70% market share on future medium-haul aircraft.

Safran says "positive" trends, including the first overhauls of recent CFM56s and General Electric GE90s, lifted revenue in its aftermarket division by 11.3%. Full-year recurring operating income for the propulsion business hit €1.6 billion, an increased margin of around 20% of revenues. ■

TAX MICHAEL GUBISCH LONDON

WTO agrees to check Boeing subsidy claim

European regulators' request to investigate tax breaks for Boeing has been granted by the World Trade Organization in the latest round of the long-standing dispute between Airbus and its US rival over state subsidies.

The WTO says it has established a panel to scrutinise a \$8.7 billion package of tax credits the State of Washington arranged for Boeing in November 2013 as an incentive to keep final assembly of the in-development 777X in the Seattle area.

The latest round of the decade-old dispute revolves around the extension until 2040 of existing tax credits that the EU says were found to be illegal in 2012. The tax credits were originally due to expire in 2024, having been granted to Boeing in 2003 for the 787 programme.

US regulators argue that the package is consistent with WTO agreements. When the EU filed its complaint in December 2014, Boeing labelled the move "an effort to further delay EU compliance with the WTO's 2011 ruling that launch aid [granted to Airbus] is an illegal, market-distorting subsidy". ■



Read the full story of Airbus and Boeing's dispute in our report:
flightglobal.com/wto

NARROWBODIES EDWARD RUSSELL WASHINGTON DC

Delta gets to front of queue for Blue1's 717-200s



The aircraft would join 88 models subleased by Delta in 2012

Delta Air Lines is the leading bidder for up to seven used Boeing 717-200s from SAS Group subsidiary Blue1, a source close to the matter tells FlightGlobal.

The Atlanta-based carrier has beaten competing offers from a number of other carriers, including Hawaiian Airlines and Qantas Airways, for the 110-seat aircraft, the source says.

Blue1 has nine 717s, with an average age of 15 years and build dates from 1999 to 2001, our Ascend Fleets database shows. Five are in service and four in storage.

Italy's Volotea will take two of the aircraft from SAS in deals disclosed earlier in February.

SAS said in December it would withdraw the remaining aircraft from service and replace them with 737-600s this year.

The aircraft would join the 88 717s that Delta subleased from Southwest Airlines in 2012, a key part of the Atlanta-based carrier's scale-back of its 50-seat regional jet fleet. The mainline carrier operates 55 of the type, with the remaining 33 scheduled to join its fleet this year, Ascend shows. ■

“

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SCAN FOR MORE INFO

SINGAPORE AIRSHOW 2014 FACTS & FIGURES

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- ▶ **1,018** PARTICIPATING COMPANIES FROM 47 COUNTRIES AND REGIONS
- ▶ **65 OF THE TOP 100** AEROSPACE COMPANIES PARTICIPATED
- ▶ **274** OFFICIAL DELEGATIONS FROM 76 COUNTRIES AND REGIONS
- ▶ **45,152** TRADE ATTENDEES FROM 125 COUNTRIES AND REGIONS
- ▶ **CLOSE TO 70** CEOs, PRESIDENTS AND CHAIRMEN FROM VARIOUS AIRLINES AND INDUSTRY ASSOCIATIONS ATTENDED
- ▶ **1,132** HIGH-LEVEL MEETINGS TOOK PLACE BETWEEN OFFICIAL DELEGATIONS AND EXHIBITORS

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AIRSHOW



Triton plans bring flying visit from Global Hawk
SHOW REPORT P20

OPERATIONS MICHAEL GUBISCH FRANKFURT

TaxiBot sets out for the wider world

With certification trials of narrowbody robotic tractor ongoing, IAI gets Lufthansa support to assess larger version with 747

Israel Aerospace Industries and Lufthansa Technik's ground services unit LEOS have signed a tentative agreement to jointly conduct certification tests for an in-development widebody version of IAI's pilot-controlled tow tractor TaxiBot with a Boeing 747-400.

Last year, the parties completed certification trials for the semi-robotic vehicle's existing narrowbody variant with a decommissioned Lufthansa 737-500 at Frankfurt airport. Now, they plan to extend their co-operation to undertake similar tests with a 747-400 in the autumn.

Certification of the 12-wheel tug, which will be capable of towing aircraft of the Airbus A380's size, is set for early 2016, IAI executive vice-president Yehoshua Eldar said in Frankfurt on 19 February. The hybrid-powered vehicle was built by French tug manufacturer TLD – which also produced the narrowbody version – and started drive tests last year.

GATEWAYS

The main objective of employing a tug for taxiing instead of the aircraft engines is to reduce fuel consumption and noise on the ground. IAI estimates that the use of TaxiBot can deliver an 85% fuel saving during taxiing, while noise and probability of engine damage through foreign object debris ingestion are also halved.

Whether Frankfurt airport will be used again for the certification trials is not yet clear. The hub is being evaluated as the location for the trials, in addition to a number of other gateways, says LEOS innovation director Gerhard Baumgarten.



A widebody vehicle is in test



Pilot-controlled tugs now move 737s to Frankfurt's runway 17

Lufthansa's 747-400 will not need to be de-registered, but will be fitted with a bespoke nose wheel leg equipped with strain gauges to measure loads during the trial. The airline says it has not yet decided whether to sell, part out or return the aircraft to service after the test.

Last year, IAI and Air France signed a similar memorandum of understanding to study and potentially test widebody towing operations with TaxiBot at Paris Charles de Gaulle airport during the second quarter of 2015. This will be complementary to the trial with the 747 as it will involve aircraft types such as the 777, A330 or A340, says IAI programme director Ran Braier.

Meanwhile, Lufthansa is testing the narrowbody TaxiBot – certificated by European and Israeli regulators in November 2014 – for regular passenger flights with its 737 fleet in Frankfurt, through a six-month operational trial which will continue until May.

Pilots use the tug to taxi from the aircraft stand to the runway. Today, the trial only covers flights departing from runway 18, as the taxiways in that vicinity provide enough space to detach the tractor without holding up other aircraft. But discussions are

under way with airport operator Fraport to potentially extend the trial to flights departing from other runways, says Baumgarten.

Lufthansa is also evaluating potential engine starts during taxi operations. This will not be possible for the airline's classic-generation 737 fleet, as the air-

Aside from saving fuel and avoiding noise, the practice of towing aircraft to the runway has improved ground traffic flow

craft are not equipped for automated engine starts. Pilots have to manually manage the start procedure, which would be unsafe to attempt when one pilot is looking outside to taxi the aircraft.

First officer Raphael Gabel says the current practice of starting the engines while TaxiBot is detaching from the aircraft is not creating any significant delay. As the detachment takes about 1min, one of the two engines is usually running stable when the tractor moves away from the aircraft. The CFM International CFM56-powered 737 requires

2min of engine warm-up time before take-off, he says.

Aside from saving fuel and avoiding noise, the practice of towing aircraft to the runway has improved ground traffic flow around the airport's terminal, says LEOS managing director Peter Unger. In conventional operations, engines are started after push-back from the stand, so there is a certain time period before aircraft can taxi under their own power, which can cause hold-ups for other aircraft in the vicinity. Such congestion is reduced if departing aircraft can move ahead straight after push-back, Unger says. Ground vehicle traffic can also be improved, as there is no jet blast from the engines of taxiing aircraft.

APPROVAL

The benefits of employing alternative taxi procedures, such as TaxiBot, can be significant at large and busy airports, says Unger. But this may be less relevant at smaller gateways with short taxi distances, he says.

Lufthansa is phasing out its 737s, with the last of the twinjets set to retire in 2016 or, at the latest, 2017. Flightglobal's Ascend Fleets database records the carrier as still operating nine -300 and 12 -500 examples.

Airbus and IAI trialled a prototype of the TaxiBot with an ex-British Airways A320 at Chateauroux airport in France in 2012, and the company has since completed practical tests for a no-technical-objection approval by the airframer. In October 2014, IAI said that the approval should "soon" be extended to the European twinjet.

LEOS envisions a potential fleet of up to nine TaxiBot tractors to conduct 60-70% of taxi operations from aircraft stands to the runway for the parent carrier's narrowbody fleet, says Unger. But the group has not disclosed any timeline for that initiative. Taxi-in operations for arriving aircraft are not currently planned, he says. ■

AVALON 2015

The Avalon air show – held south of Melbourne every two years – will never be known for big commercial aircraft orders, but is an important venue for defence contractors to network with one of the world's most potent small air arms: the Royal Australian Air Force. Australia's passion for aviation and its vast geography also makes the event a great marketing opportunity for the makers of business jets, general aviation aircraft and helicopters, and for local industry and academia to shine a spotlight on their know-how. Show report by Emma Kelly and Greg Waldron



Commonwealth of Australia



Greg Waldron/Flightglobal

A Block 30 air vehicle was on show, alongside the F-22 Raptor

UNMANNED SYSTEMS

Triton plans bring flying visit from Global Hawk

With Australia planning to buy at least seven examples in the MQ-4C Triton, the US Air Force sent one of its Northrop Grumman Global Hawk unmanned air vehicles to make an Avalon show debut.

Flown from Beale AFB in California via Guam, the Block 30-standard surveillance aircraft made a night-time landing before appearing in the static display, where it was positioned with a pair of the USAF's Lockheed Martin F-22 Raptors.

Canberra plans to acquire the Triton – which is now in testing for the US Navy – to complement its future fleet of eight Boeing

737-based P-8A Poseidon maritime patrol aircraft.

"The Triton's 24h endurance will allow it to conduct patrols along Australia's northern borders," said Royal Australian Air Force Grp Capt Guy Adams during a briefing hosted by Northrop and the USN.

A USN official speaking at the show says that three examples of the Triton aircraft are now at the service's Patuxent River testing facility in Maryland. Laboratory and ground testing of the aircraft's sensor suite is under way, and airborne sensor tests are planned "in the spring", the official adds. ■

SELECTION

Thales tipped for OneSky contract

Canberra due to confirm \$473m deal to put in place ambitious civil-military air traffic management system

Australia's government is set to name Thales as the successful bidder for a A\$600 million (\$473 million) OneSky harmonised civil-military air traffic management system contract.

Final negotiations for the deal are still under way, Airservices Australia confirms. The air navigation service provider declined to comment on the successful bidder ahead of a planned government announcement on 27 February, but industry sources indicate that Thales has won out over rival Lockheed Martin.

OneSky is set to combine civil and military ATM in what is touted as a world first. A request for tenders, which closed in October 2013, drew six bids. There followed an "exhaustive evaluation process", Airservices deputy programme director and manager transition John Moore told a OneSky conference at the show.

A new civil-military ATM system (CMATS) will replace the existing Thales-based Australian Advanced Air Traffic System and Australian Defence Air Traffic System, both of which are coming to the end of their service lives and would struggle to cope with a forecast doubling of traffic by 2030. CMATS is to benefit from

and support new technologies, such as conflict-detection tools and surveillance-based planning.

The project – within which Australia's two existing flight information regions will be combined – represents the biggest and most complex ATM change in Australian history, says Jason Harfield, Airservices' executive general manager for future service delivery. It will be implemented in phases, with initial operational capability planned for 2018 and final operational capability for 2020/21. The partners are planning a five-stage implementation process designed to manage risk, with the aim of realising benefits as soon as possible.

"It's not just changing a piece of kit," says Harfield, highlighting the complexity of a system that will manage 11% of the Earth's airspace and seamlessly combine civil and military operations. "We are on the cusp of doing something that has not been done anywhere else in the world."

Airservices has already started engaging with industry, Harfield says, with the service provider acknowledging that consultation is vital for successful implementation. "This is big, but we have confidence we will deliver." ■



Printed APU takes shape at Monash
SHOW REPORT P22

ACQUISITIONS

RAAF chief sets transformation plan

Service leader describes networked platforms, data sharing and new types as heralding fundamental change in capability

The Royal Australian Air Force (RAAF) has ambitious plans that emphasise the seamless integration of airborne assets as it continues to induct new platforms.

Speaking with Flightglobal on the sidelines of a service-run conference, chief of air force Air Marshal Geoff Brown said he foresees its operations as fundamentally changing in the next 10 years, with a reliance on data produced from a range of assets and improved situational awareness.

Dubbed 'Plan Jericho', the concept will see greater connectivity, allowing for the dynamic re-tasking of aircraft, as well as improved integration between the RAAF, other service branches and coalition partners.

Other officers speaking at the same conference made much of the Lockheed Martin F-35's potential in the intelligence, surveillance and reconnaissance areas, in addition to its combat capabilities. Australia has commitments for 72 F-35s, but could eventually acquire up to 100.



KC-30A tankers will be joined in service by the EA-18G Growler

Brown says eight RAAF crew members are embedded with a US Navy Boeing EA-18G Growler squadron to learn about the type's electronic warfare capabilities. In addition to its current 24 F/A-18F Super Hornets, Canberra has orders for 12 EA-18Gs.

Australia's aircraft have performed well in coalition combat operations against Islamic State militants in Iraq and Syria, Brown says. This includes F/A-18Fs, a Boeing 737-based E-7A Wedgetail

airborne early warning and control system aircraft and an Airbus A330 multi-role tanker transport; designated the KC-30A in Australian service.

Brown gives particularly high marks to the KC-30A, which has refuelled a broad range of coalition fighters during missions lasting 11-12h, with extremely high dispatch reliability.

On the issue of the KC-30A's problematic in-flight refuelling boom, Brown says progress is

being made, and that the capability should be available across the RAAF fleet by some time in 2016. The operational boom will allow the tanker to refuel types such as the RAAF's Boeing C-17, E-7A and future P-8 Poseidon, plus US Air Force aircraft and other allied types, such as Singapore's Boeing F-15SGs.

Brown also revealed that RAAF personnel are working at Creech AFB in Nevada to familiarise themselves with the USAF's General Atomics Aeronautical Systems MQ-9 Reaper unmanned air system.

He indicates that while Australia has no immediate plans to obtain such a capability, it could be included in a future defence White Paper, the next iteration of which is due for release in the middle of this year.

"We need to transform ourselves into a truly integrated, networked force that can realise the potential of this technology, and maintain our position as master of the air domain," he says. ■

SURVEILLANCE

Wedgetail impresses during active duty over Iraq

Recent operational experience with the Boeing E-7A Wedgetail airborne early warning and control system aircraft has established the platform's effectiveness for the Royal Australian Air Force, the service says.

Wg Cdr Paul Carpenter says the receipt of initial operational capability (IOC) status in December 2012 was a milestone in the type's service history. He adds that the 737-based surveillance aircraft performed very well in overseas exercises, which helped the air force to hone its operational and logistics procedures for the type.

The E-7A has also seen active duty in two missions: the search for missing Malaysia Airlines flight MH370 off western Australia in March and April 2014,

and during the coalition operation against Islamic State militants in Iraq and Syria.

With dozens of aircraft from several countries involved in the

initial search for MH370, the Wedgetail played an important role in guiding the search and ensuring the safety of participants, Carpenter notes.

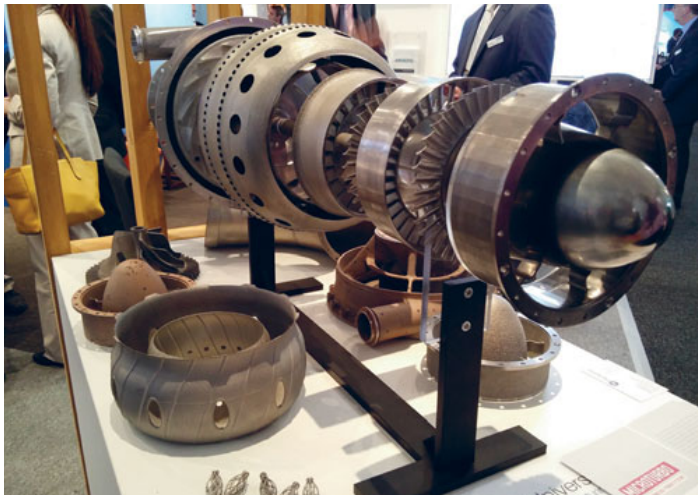


Missions launched in the Middle East typically last for 12-16h

The single Wedgetail deployed to the Middle East has shown a reliability rate of 90%, with the air force able to draw on the global 737 support chain. Carpenter says the relative youth of the airframe against the US Air Force's Boeing E-3 means fewer aircraft are needed to generate high sortie rates.

Over Iraq, the E-7A is typically flown every other day on missions of 12-16h, and Carpenter says its Northrop Grumman multi-role electronically scanned array radar has generated "quality data".

Prior to operations over Iraq, however, Carpenter says few Wedgetail pilots had experience in refuelling via a boom; mainly owing to delays with installing the system on Australia's Airbus A330 tanker transports. ■



Aluminium, titanium and nickel alloy were used during the process

TECHNOLOGY

Printed APU takes shape at Monash

University researchers claim Safran Sapphir replica is first entire aircraft engine to be created by cutting-edge process

Australia's Monash University has produced a full-sized auxiliary power unit using 3D printing, and intends to test individual components in a real engine.

The engine, which the university displayed at its stand, is a replica of Safran's Sapphir APU for the Dassault Falcon 20 business jet. Since this is an old design, with no computerised drawings available, university researchers needed to carefully analyse engine components before embarking on the printing process.

Two units were printed. One appeared at the show, while the other is at Safran's Microturbo unit in Toulouse, France.

Materials used in the printing process included titanium, aluminium and nickel alloy. Overall, 14 major components were printed. A Monash representative says the individual parts will eventually be tested in real conditions, but that there is no timeframe yet set for this work.

The entire project took one year, while printing time for a single engine was about one month.

Researchers claim this is the first time an entire aircraft engine has been printed. Their hope is that printing could one day be an effective way of producing fully functional aero engines. ■

See Special Report P35

ORDERS

RFDS hones PC-24 configuration

Swiss manufacturer Pilatus brought a full-scale mock-up of its PC-24 business jet to the show, having secured its first customers for the type in Australia.

The Royal Flying Doctor Service, Western Operations (RFDS WO) is among the launch customers for the PC-24, having ordered four of the Williams International FJ44-4A-powered aircraft.

Pilatus also has secured orders from private customers in Australia.

The RFDS (WO) will take delivery of its first PC-24 following the type's certification in 2017.

Pilatus – which is scheduled to perform the first flight of its new product in May – is currently working with the operator on the cabin configuration for its jets. ■

PROGRAMME

Airvan 10 gets deposits as certification flies near

Mahindra Aerospace is aiming to submit certification documents for its Airvan 10 to Australia's Civil Aviation Safety Authority in the third quarter of this year.

The Airvan 10 is a stretched, 10-seat version of the Latrobe Valley, Victoria-based manufacturer's eight-seat Airvan 8 utility aircraft. Owned by India's Mahindra Group, the company has been working on the new programme since 2011, with first flight achieved in May 2012.

Certification with the US Federal Aviation Administration is expected to follow two months after initial Australian certification, says the manufacturer.

Meanwhile, Mahindra says it is starting to take deposits from its dealers for the Airvan 10,

which appeared at the show along with an Airvan 8.

Mahindra recently secured a five-aircraft order for the Airvan 8 from its authorised dealer in China, Shaanxi Jinggong General Aviation Company, with deliveries scheduled to take place over the next 12 months.

The manufacturer says it has also partnered with Airglas for the development of skis and a larger nose fork for the Airvan 8, in order to expand the utility of the aircraft across Alaska, Canada and other countries with remote airstrips in cold climates.

Completion of the ski programme is scheduled for the second quarter, while the nose fork already has supplemental type certification approval and is available through Airglas. ■

DELIVERIES

S-92 flies in for new Bond role

Bond Helicopters Australia has taken delivery of two Sikorsky S-92s, as part of a four-aircraft deal.

The rotorcraft will be deployed to support oil and gas operations in Western Australia and Darwin, says John Boag, Bond Helicopters Australia's managing director. The remaining two will be delivered ahead of schedule later this year, he adds.

Bond's first S-92, which seats up to 19 passengers, was formally

delivered at the show. Flightglobal's Ascend Fleets database records aircraft VH-NYZ as so far joined by another registered as VH-NZW, both built in 2014.

Sikorsky also used the show to name Brisbane-based Sikorsky Helitech as the world's first authorised customer support centre for the GE CT7-engined S-92. The company will provide maintenance services for Australian and other regional operators of the type under the arrangement. ■



The new aircraft are set to support oil and gas operations



Rival bidders face off as Crowsnest decision looms
DEFENCE P24

DEVELOPMENT GREG WALDRON BENGALURU

Izdeliye 30 engine starts rig testing for T-50 fleet



AirBeamImages

Current prototypes of the fifth-generation type use the Saturn 117S

The Izdeliye 30 engine for Sukhoi's T-50 fighter is undergoing rig testing, and will enter flight trials in 2017, says United Aircraft Corporation chief Yuri Slusar.

Speaking at the Aero India show in Bengaluru, Slusar said Russia has always intended to conduct its T-50 test campaign in two phases; the first using Saturn 117 engines and the second Izdeliye 30s. The developmental fighter's existing powerplant is a "very deep mod-

ernisation" of the AL-31 that powers Su-27 and Su-30 fighters, and is "sufficient" for the current stage of the T-50 test campaign, he adds.

Sukhoi has six T-50 test aircraft – four flight-test examples and two for ground tests – and three more will join the fleet in 2015.

"Everything is on track," says Slusar. "We are moving on as per the schedule agreed with our customers." Russia is to acquire the type for its air force, with India also to introduce it. ■

PROGRAMME GREG WALDRON MELBOURNE

Savings and risk balance keep F-35 on track – DoD

Lockheed Martin's F-35 programme is "seeing slow, steady progress", according to US Air Force Lt Gen Christopher Bogdan, executive officer of the Department of Defense's joint programme office.

Speaking at the Avalon air show near Melbourne, Bogdan said that memories of severe delays and problems prior to the F-35's "re-baselining" exercise in 2010-11 continue to overshadow the programme, but that much progress has been made in finding ways to drive down costs. Crucially, the relationship between the US government and key contractors Lockheed and Pratt & Whitney – which he laid bare at the same event two years ago – has improved, mainly through a better balancing of risk between the parties.

Bogdan estimates that by 2019 the cost of a conventional take-off and landing F-35A will be around \$80-85 million, including its P&W F135 engine, inflation and a profit margin for contractors.

"This gets close to what you pay for a fourth-generation aircraft," he notes. "If a country has a choice between a fourth-generation aircraft and a fifth-generation aircraft at roughly the same price, that is a pretty easy decision."

Price-reduction efforts include a "cost war room" and a "blueprint

for affordability" programme, which incentivises contractors to find savings. Bogdan hopes to also include Foreign Military Sales under a block buy proposal, which could help drive economies of scale through multi-year contracts.

Bogdan also remains confident that the US Marine Corps is on track to grant the F-35B initial operating capability this year. He adds that discussions with potential overseas customers, including Singapore, are deepening.

"The best marketing you can do is to succeed," says Bogdan.

Lockheed delivered 36 F-35s in 2014, with this total planned to rise to 45 this year, followed at annual rates of 61, 72, 93 and 102, before reaching 120 in 2020.

Meanwhile, Israel has signed a \$2.82 billion contract for its next batch of 14 F-35A "Adir" fighters, which it says are being acquired at a unit cost of around \$110 million. Its deal also funds simulators, the establishment of a national maintenance capability and preparations to integrate additional Israeli-developed systems with the aircraft, and includes options for a further 17 of the type.

Israel's first two aircraft from a previous order for 19 F-35As will be delivered at the end of 2016. ■

Additional reporting by Arie Egozi in Tel Aviv

ORDER BETH STEVENSON LONDON

HammerHead UAV takes off as Italy confirms first buy

Rome announces intention to acquire six medium-altitude, long-endurance surveillance aircraft, for delivery from 2016

Piaggio Aerospace has secured its first customer for the P.1HH HammerHead unmanned air vehicle, with Italy's air force confirming its intention to buy three systems totalling six aircraft and three Selex ES ground control stations.

The purchase was announced on 26 February, two days after the company had confirmed its achievement of a December first flight with a prototype of the Avanti II-derived UAV. This took off from Trapani Birgi air base for a shakedown flight performed over the Mediterranean Sea "at a significant range of speed and altitude", Piaggio Aerospace says.

Prototype 01 – which is characteristic of the HammerHead's final aerodynamic design, with an extended-span main wing and on-board control systems – is now involved in a development and certification test campaign.

"We are truly delighted about this decision," says Piaggio Aerospace chief executive Carlo Logli. "It confirms the strong partnership we have with the Italian air force and showcases the P.1HH as one of the most advanced systems to enter the market."

The HammerHead concept was unveiled at the Paris air show in 2013, and a technology demonstrator flown late the same year. ■



Italy's air force will acquire six of the aircraft

Piaggio Aerospace



REQUIREMENT DOMINIC PERRY CRAWLEY & HAVANT

Rival bidders face off as Crowsnest decision looms

Thales and Lockheed Martin talk up their proposals as UK prepares to select next-generation maritime AEW system

With the UK Ministry of Defence expected to reveal its choice of a next-generation rotary airborne early warning (AEW) system early in the second quarter, the two bidders for the Crowsnest requirement are making a final push to secure the £500 million (\$769 million) deal.

Incumbent supplier Thales UK and Lockheed Martin UK are vying to outfit eight of the Royal Navy's AgustaWestland AW101 Merlin HM2 helicopters with a new AEW radar and mission system, and deliver another two kits in reserve. These will replace the service's Westland Sea King 7 airborne surveillance and control (ASaC) rotorcraft, to be progressively retired from 2016 to 2018.

SOLUTIONS

Thales UK is confident that a promise of early delivery, low cost and simplicity will help to swing the decision in its favour, following the submission of final bids at the end of January.

"We recognise that in this age of austerity there is not a lot of money to splash around on 'gold-plated' solutions," says Matt

Avison, the company's sales director intelligence, surveillance and reconnaissance and defence mission systems. Thales has proposed a modernised version of its Cerberus mission system and Searchwater 2000 mechanically-scanned array radar, currently in use on the Sea King ASaC fleet.

Avison cautions that the RN cannot risk "having a technology demonstrator" replace its existing organic AEW coverage, particularly once the service's flagship aircraft carrier HMS *Queen Elizabeth* enters service in 2018.

"Our view is that an AESA [active electronically scanned array] radar will not be sufficiently robust in the timeframe the navy requires, and that it is not the most technically advantageous solution," he says.

"This has got to work from day one. When Crowsnest comes in the *Queen Elizabeth* will be at sea, and we can't afford to be without force protection."

The MoD requires Crowsnest to be operational from 2018, but Thales says it can deliver a fully operational system 12 months ahead of this schedule.



Lockheed Martin UK

Lockheed Martin proposes twin-array radars on side-mounted pods

Avison notes that over 50% of the existing hardware from the ASaC system will be re-used, and that converting operators onto the upgraded variant will be relatively straightforward.

Flight tests to check the fitment of Thales's side-mounted, hinged radar assembly – which contin-

"You would struggle to go to any major supplier in the world and find one that is not working on an AESA radar to combat the next generation of threats," says Younus Mustafa, airborne military solutions director at the firm's Integrated Systems business unit. "We have looked at the customer's requirements and the capability they require and developed an AESA radar solution that meets them."

POTENTIAL

Roll-on, roll-off equipment racks are mounted on the Merlin HM2's existing seat rails, and a pre-installed software cartridge in the existing anti-submarine warfare operator consoles will recognise the switch to the AEW mission, Mustafa says.

Its new mission system also features a number of operator "decision aids", such as the sensor correlation engine from the US Navy's Lockheed/Sikorsky MH-60R Seahawk.

Flight trials using the Vigilance pods were performed between July and November 2014 at partner Qinetiq's Boscombe Down facility in Wiltshire, with 22h of flight time amassed during 11 sorties. The radar pods, which weigh slightly more than a standard torpedo load, "had no adverse effects on the handling of the aircraft", says Mustafa.

Vigilance also has export potential, he says, with several "international parties" already interested.

The RN is expected to continue operating the Merlin HM2 until potentially 2040. ■

"This has got to work from day one. When Crowsnest comes in the *Queen Elizabeth* will be at sea"

MATT AVISON

ISR sales director, Thales UK

ues to use a distinctive inflatable radome – were conducted from AgustaWestland's Yeovil facility in Somerset last November. Around eight sorties were performed, says Avison. No significant problems were detected, but "two or three" minor issues have since been addressed.

Regardless of the outcome of the UK contest, Avison says there are "other nations interested in this solution", for both fixed- and rotary-wing platforms.

Lockheed, meanwhile, rebuffs its rival's claims of costliness and over-complexity levelled at its bid, and also has pledged to deliver full operational capability a year ahead of schedule. Named Vigilance, its system proposes a pair of twin-array AESA radars produced by Israeli partner Elta Systems, mounted in pods on either side of the rotorcraft.



AgustaWestland

Thales' side-mounted assembly has a distinctive inflatable radome



Surf Air rides PC-12
wave to success
BUSINESS AVIATION P28

ENHANCEMENTS DAN PARSONS WASHINGTON DC

Lockheed set for more F-16 upgrades

Additional nations expected to fund V-model modernisation, while airframe service life could be extended to hit 12,000h

The US Air Force has scrapped a plan to install advanced radars on some of its Lockheed Martin F-16s, but the company is pressing forward with a proposal to outfit other nations' aircraft, in the hope that it will eventually follow suit.

USAF officials scrapped a comprehensive upgrade effort for F-16 Block 40 and 50 aircraft called the combat avionics programmed extension suite (CAPES) in the service's current fiscal year budget, but preserved money over five years to replace their mission and display computers.

"Those are the foundational systems that need to be installed to support an active electronically scanned array [AESA] radar upgrade in the future," says Rod McLean, vice-president of Lockheed's F-16/F-22 integrated flight group.

CAPES was intended to be a joint programme between the USAF and Taiwan, which is now performing the upgrades unilaterally to its 144-strong fleet of A/B-model fighters.

Washington was to use the activity to keep its F-16s technologically relevant until sufficient Lockheed F-35A Lightning IIs have entered service from 2016, but air force officials chose to follow an incremental path, rather than fund an AESA upgrade in the near term.

"Even though the US Air Force pulled their involvement, there still is a baseline capability that we will install in the Taiwan air force F-16s that will be applicable to the US Air Force in the future," McLean says.

Taiwan is the launch customer



The US Air Force is struggling to keep its current fleet relevant until it has sufficient F-35s

for Lockheed's F-16V configuration, which involves mission computer upgrades, structural reinforcements and the integration of an AESA sensor: in this case, the Northrop Grumman APG-83 scalable agile beam radar.

"We are starting to see a number of customers beginning to line up behind that configuration," McLean says. "We should hear some news by the end of the year for additional upgrade contracts to the V configuration."

The F-16 needs more than an avionics upgrade to continue flying for much longer than its originally intended 8,000h service life. Many operators, including the USAF, are considering pushing the type to at least 10,000h – if not 12,000h.

"It's quite realisable that we can get up to 12,000h on the airplanes," McLean says. "They will continue to be the backbone of the US Air Force fleet for a num-

ber of years until the F-35 comes online. Already, they are the backbone of many international coalition partners' fleets, as they are heavily engaged in the fights around the globe."

"[F-16s] will continue to be the backbone of the US Air Force fleet for a number of years"

ROD MCLEAN

Vice-president, F-16/F-22 integrated flight group, Lockheed Martin

Lockheed is putting an F-16 through stress and fatigue testing in order to design a service life extension retrofit kit that would allow Block 40/50 examples to remain in use for up to 12,000h, with the activity due to conclude later this year. The test airframe is being put through the equivalent stress of three 8,000h

service lives, and has passed 16,000h.

"As the test progressed, we saw some occurrences and made some repairs," McLean says. "We updated our models to reflect that and then identify a kit, a set of parts and components or structure members that we'll need to go off and procure and install on the airplane to take it to 10,000 or 12,000h." Initial assessments indicate "nothing significant" such as wholesale bulkhead or wing replacement is needed, he adds.

Lockheed is still building about one F-16 per month at its Fort Worth, Texas, manufacturing facility on a line with orders that will currently sustain it through 2017. McLean says the company hopes to close a deal with another new-build customer – either a Middle Eastern or South American nation – before the end of this year. ■

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DELIVERY KATE SANSFIELD LONDON

Surf Air rides PC-12 wave to success

Members-only VIP airline puts faith in Pilatus turboprop as high take-up prompts plans to grow all-you-can-fly service in USA

The 1,300th Pilatus PC-12 entered service on 24 February with US members-only VIP airline Surf Air.

The Santa Monica-based operator is now plotting to expand in order to cater for the booming demand for its all-you-can-fly, single-engine turboprop-based scheduled service.

Surf Air launched around two years ago, offering its members unlimited flights on a fleet of three pre-owned PC-12s for a monthly fee – currently \$1,750.

“We now fly to seven destinations within California with a fleet of seven PC-12s, including four new eight-seat NG models,” says Surf Air chief executive Jeff Potter.

“We have brought the benefits of private aviation to a much broader audience and the reception has been overwhelming,” he says. “In the last year our membership has grown from 300 to



The 1,300th PC-12 to enter service joins six others at Surf Air

over 1,200, and we expect the numbers to grow to 5,000 by the end of 2015.”

The high take-up rate for the service persuaded Surf Air last August to place an order for 15 PC-12NGs and options for another 50. “We expect to take another eight aircraft this year and a dozen in 2016, which will help to support our expansion,” says Pot-

ter, who was formerly chief executive of US low-cost regional carrier Frontier Airlines and members-only VIP travel club Exclusive Resorts.

Surf Air, he explains, has secured an agreement with Pilatus whereby the Swiss airframer will not sell new NGs to any US operator with a similar programme for five years. “We will retain this ex-

clusivity as long as we exercise 12 options a year. Based on the demand for the service so far, this is not a problem,” says Potter.

The company is planning to expand its coverage across the USA, starting at the end of the year with a Texas-based service. Operations in Florida and the northeast are also mooted.

“If we continue to grow at the current rate, we will have to order more aircraft,” Potter says.

Surf Air is sticking with the PC-12NG, he says. “We made a resounding decision from the start to go with Pilatus. With its short field capability, low operating costs and large cabin, the PC-12NG is ideal for this type of service.”

Surf Air has a typical load factor of around 60% per flight. “In order to enhance the customer experience we try to limit the number of passengers to five,” says Potter. ■

DELAY KATE SANSFIELD LONDON

SyberJet takes control of SJ30i

First flight of the SJ30i has been pushed back to the end of the year following SyberJet Aircraft’s decision to bring in house the electronic engineering work involved in incorporating the light business jet’s redesigned cockpit.

The revamped twin was scheduled to make its maiden sortie this quarter, equipped with its new SyberVision avionics suite. The engineering work was originally assigned to an undisclosed private company. “We have decided to take full control of the engineering project,” says SyberJet’s general manager, Mark Fairchild. “This has delayed the SJ30i certification by a few months, but it is a price worth paying.”

The SyberVision suite, which is based on Honeywell’s Primus Epic 2.0 system, comprises four 12in displays and a host of features including synthetic vision, a moving map display system, electronics charts, TCAS II, dual flight

management systems, graphical flight planning and onboard weather radar. “This is a very advanced cockpit for this market segment,” Fairchild says.

SyberJet has redesigned the side walls and ledges to provide maximum room for the flightcrew, while the engine control panel has been repositioned to the overhead panel to reduce visual clutter.

“We are manufacturing a business jet which is mainly targeted at owner-pilots, so attention to detail in the cockpit is paramount,” Fairchild says.

Certification and service entry of the Williams International FJ44-3AP-2A-powered twin is scheduled for late next year, which should coincide with first flight of the re-engined SJ30x.

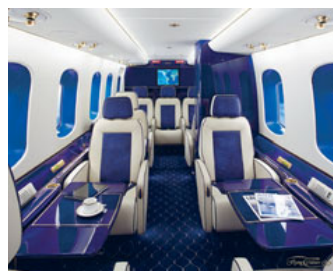
Equipped with the more fuel-efficient, higher-thrust turbofan engines, the SJ30x will be the standard version following entry into service, set for 2017. ■

INTERIORS KATE SANSFIELD LONDON

VIP completion of S-92 a big deal for Flying Colours

Canadian maintenance, repair and overhaul company Flying Colours has completed its first VIP refurbishment of a Sikorsky S-92, marking its first foray into the large/heavy-twin helicopter completions business.

The Peterborough, Ontario-based company, which has already outfitted a number of smaller S-76s, now plans to expand its helicopter interiors offering.



Refurbishing large/heavy-twin helicopters is a new direction

“We have always been interested in pursuing the helicopter market,” says Flying Colours vice-president Sean Gillespie.

“With the combination of our experienced workforce and the hangar capacity at both our facilities [including St Louis, Missouri], we are well positioned to grow that side of our business in the future.”

Work on the privately owned S-92 began in Peterborough last October and the completed aircraft was handed over to its owner late last month.

The nine-passenger aircraft features an electric blue-themed interior designed by Flying Colours, forward four-place and aft five-place white leather club seating, a forward lavatory with a granite flooring finish and extensive cabinetry work. ■



Engines of change
FEATURE P30



Focus areas include pushing operators to improve the effectiveness of simulator-based training

REGULATION DAVID LEARMOUNT COLOGNE

EASA mends the rules with tighter focus on outcomes

The executive director at Europe's safety agency has overseen a wholesale shift in mindset

If a regulator dismantles its rule-making directorate it is a sign that things are changing, and at EASA they are.

Executive director Patrick Ky took over the EASA top job in September 2013, and a year later he closed the rulemaking department. "If you have a rulemaking directorate," he explains, "the director is judged by how many rules he makes, or how many existing rules he 'improves'." The result, he says, is ever-fatter rule books, the content of which nobody could possibly retain, and the complexity of which becomes "impossible to work with".

When he first arrived, Ky says, he gathered his troops and told them to reduce the existing rules down to the absolute essentials, so they could all see what was really necessary.

EASA retains its power to make rules, Ky confirms, but the way the need for rules is assessed, and the way that they are made and framed, is now different. The rulemaking process now starts with a risk assessment to determine whether a

rule is needed at all, and if so what it needs to address. Only then is it framed.

ESSENTIAL

Finally, the rate of technological progress is such that prescriptive rules involving equipment can rapidly become outdated, so the future, says Ky, is performance-based rulemaking (PBR), with prescriptive rules only where they are essential. Mostly the latter would define capabilities and responsibilities. PBR means that the required outcome of the rule is specified, and the means by which that outcome is achieved is not the main issue. This method has been foreshadowed for years by the approval of rulings on an "equivalent safety" basis, which allows flexibility in the means by which a safety objective could be achieved.

Rulemakers still work at EASA, but within one of the four directorates: strategy and safety management, certification, flight standards, and resources and support. "Rulemakers now only work six months at headquarters," Ky explains. "Then they are

sent out on inspections so they can see what it's like to have to put EASA rules into practice."

But Ky, a noted simplifier, has actually created a new directorate: strategy and safety management, headed by Luc Tytgat, formerly the director of the pan-European single sky directorate at Eurocontrol. Why?



"Rulemakers are sent out on inspections so they can see what it's like to put EASA rules into practice"

PATRICK KY
Executive director, EASA

Ky explains: "If we are to go to PBR, we have to establish what the risk is, and to prioritise our resources and action. Luc's task is to notice what is happening out there, to recognise risk and determine where action might be needed." There are areas crying out for attention, Ky says, and ground handling, where – in simple numbers – there are more safety incidents than in any other phase of an aircraft's operation, is one of them. And in general aviation, it has started down the long path of working with the sector towards replacing regulation that was effectively commercial-aviation-light with industry-specific guidelines.

Long-serving certification director Norbert Lohl was on 1 March replaced by Trevor Woods, who previously worked on flight standards. Lohl says it was tough in the early days, building a relationship with sceptical national aviation authorities. They were essential, because EASA was so under-resourced that it had to contract out a high proportion of new tasks to the national authorities. About 20% of the tasks still are contracted out.

Woods points out how much is happening on the operations side, especially in human factors and training. EASA is preparing to drive operators towards the application of safety management systems within training departments, and towards the principle of alternative training and qualification programmes, instead of prescriptive syllabus-based recurrent training, plus the application of competency-based training.

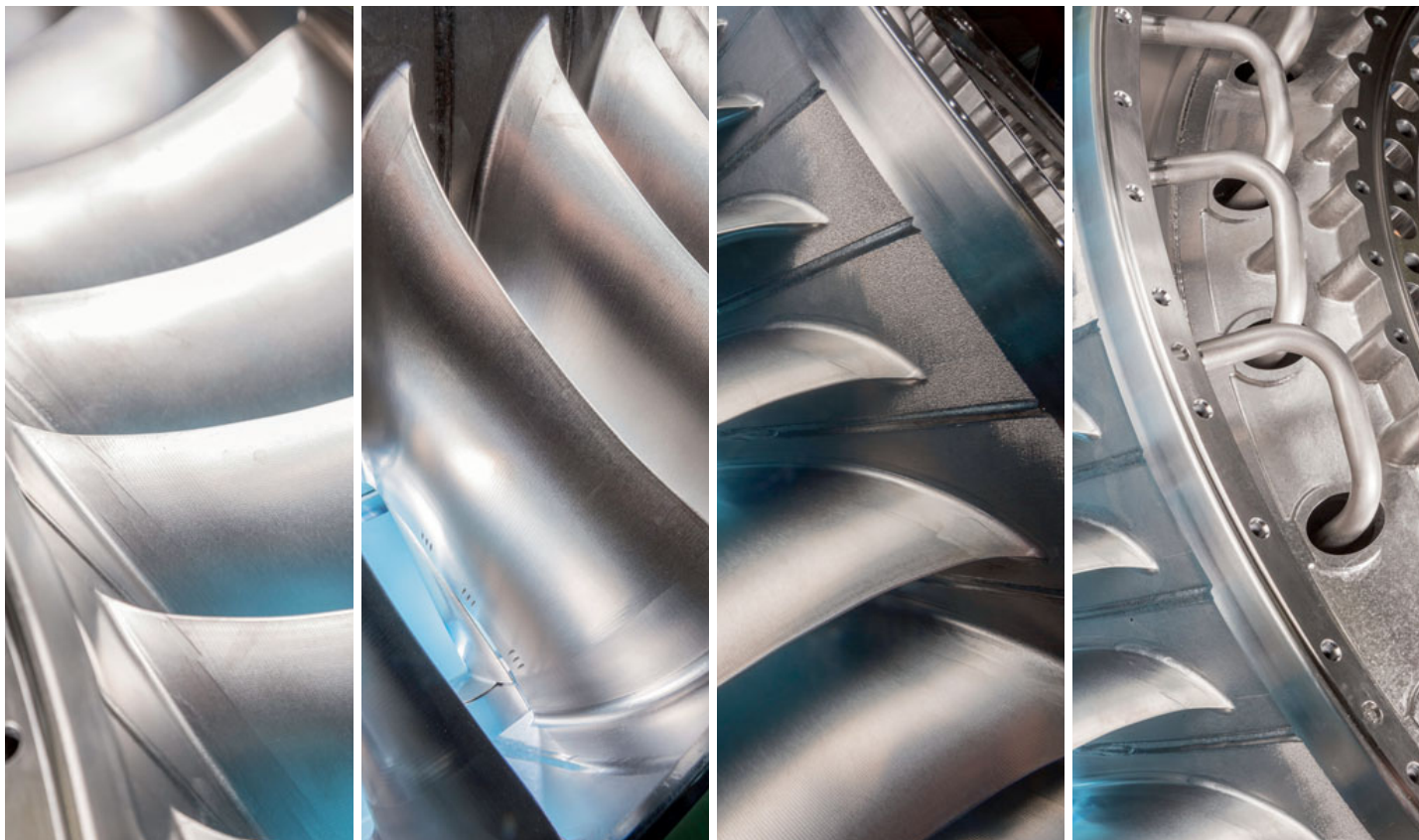
TRAINING

Aircraft manufacturers must now provide operational suitability data to prove their cockpit interfaces work. Airlines will be expected to follow the manufacturers' manuals on type rating training more closely. And work is being done to improve the effectiveness of simulators.

EASA is not blind to the fact that pilots frequently seem to be unable to cope with the unexpected, Woods emphasises, and it is looking for ways of dealing with this. ■



David Learmount's blog covers the latest safety developments: flightglobal.com/learnmount



Rolls-Royce says the largest-ever engine component made using additive layer manufacturing techniques to fly will get airborne this year

ENGINES OF CHANGE

Our latest commercial engines package covers a range of topics, from Rolls-Royce's ventures into the potentially revolutionary world of 3D printing to the question of whether or not commissioning a new engine for the Airbus A380 makes sense. We also look at how Pratt & Whitney is trying to secure a competitive advantage in the A320neo power struggle, and find out how General Electric is bolstering its Ohio outdoor test facility

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(Top) Pratt & Whitney is investing in technology to gain an edge in the A320neo engine battle; GE's Pebbles outdoor test site

RE-ENGINEING

The A380 conundrum

Despite demand from its biggest customer, Emirates, not everyone agrees it make sense for Airbus to re-power its largest airliner

STEPHEN TRIMBLE WASHINGTON DC

In a lightly attended Dubai air show press conference about 15 months ago, then-Engine Alliance president Dean Athans delivered an unexpected message. The joint venture between GE Aviation and Pratt & Whitney was evaluating a wide range of performance upgrades for the GP7200, including offering an all-new engine to power the Airbus A380.

"I wouldn't take anything off the table," Athans said at the 19 November 2013 press event. With those words, Athans opened a contentious public debate that still continues on whether Airbus should add the A380 to a long list of re-engined commercial aircraft models now in development.

How Airbus answers that thorny question could shape its own product strategy for dec-

ades, figure large in Rolls-Royce's plans for a new generation of widebody engine technology and, not least, provide a clear response to a request from by far the A380's biggest customer – Emirates – with orders for dozens of new A380s possibly hinging on the outcome.

With strong interest from Emirates and Rolls-Royce – Engine Alliance's competing supplier to power the A380 – to move forward with a re-engining programme, Airbus faces a clear choice.

Last December, Fabrice Brégier, Airbus chief executive and president, vowed that Airbus will re-engine the A380 eventually, but his comments only came after comments by the corporation's chief financial officer sowed doubts about the future of the A380.

Some prominent analysts, however, remain bewildered that Airbus is even considering the idea of re-engining the A380. Teal Group's Richard Aboulafia, a noted A380 critic, believes Airbus' corporate leadership will ultimately reject the project.

NO-BRAINER

"This is one of the great ironical moments of my career. I say it doesn't happen because I have faith in Airbus," says Aboulafia, speaking on 11 February at the Pacific Northwest Aerospace Alliance conference in Lynnwood, Washington. "If you think that they are run by, shall we say, less-than-gifted pro-

fessionals, then you'd say, oh yeah, they'll do it anyway."

Aboulafia's opposition to a re-engining programme runs deeper than his long-held opinion that the A380 has been a commercial flop. If the A380's largest customer is excluded, Airbus' backlog dwindles to 35 aircraft, representing about 14 months of production at current delivery rates. To Aboulafia, that represents a "complete absence of commercial activity".

"I say [re-engining the A380] doesn't happen because I have faith in Airbus"

RICHARD ABOULAFIA

Vice-president, analysis, Teal Group

Compounding the sales inactivity is the lack of a confirmed secondary market for the aircraft, with the first A380s delivered to Emirates due for retirement in a few years. "If you launch a re-engined version you've just made that problem so much worse," he says.

Simon Pickup, a strategic marketing director for Airbus, defended the A380's sales record in a 12 February presentation at the PNAA conference, noting that Aboulafia excludes the type's most important customer in his analysis.



At present, Airbus's A380 superjumbos are powered either by Rolls-Royce's Trent 900 turbofans or by GP7000s from Engine Alliance

» “I don’t know why he does that because we did sell 140 A380s to Emirates. They’re in the orderbook. By excluding them it gives a slightly skewed picture, I think,” Pickup says. “So every time he takes them out, we’ll put them back in again.”

Not surprisingly, Airbus believes the A380 is still slightly ahead of its time, but demand will pick up as traffic grows. Aboulafia has noted that aircraft sizes have declined as international passenger traffic has increased over time, with the 747-400 often replaced on routes by the 777-300ER. Pickup, however, points to the rise of mega-hubs that serve at least 11,000 passengers per day. That number will rise from 41 to more than 90 over the next 20 years, according to the Airbus forecast, and will drive new demand for super-jumbo aircraft, Pickup says.

Moreover, it may be unwise to exclude Emirates’ input from the strategic equation. As the single-largest A380 buyer, chief executive Tim Clark still carries much sway in Airbus’ boardroom.

“With more than half of the final backlog now invested in Emirates, their influence here is clearly key,” says Rob Morris, head of Flightglobal’s Ascend consultancy. “I suspect they will be the ultimate drivers of the re-engine decision. That could also stimulate some potential replacement demand with other existing operators.”

Boeing plans to start delivering the 777-9X to Emirates in 2020 with the latest widebody aircraft propulsion system officially in development. The GE9X will enter the market two generations of engine technology ahead of GP7200s powering Emirates’ fleet of A380s, which have played a critical role in the Middle Eastern carrier’s strategy of tapping slot-controlled airports in Europe.

ECONOMICS

“Part of what’s going on is Emirates; they believe they have a seat-kilometre cost advantage with the A380,” says George Hamlin, president of Hamlin Transportation Consulting. “When the 777X comes along they are going to lose that advantage.”

Despite that economic incentive, Hamlin counts himself with Aboulafia among the analysts opposing the project. Among widebody aircraft, the A380’s operating economics will suffer even with new engines, as the Airbus A350, 787 and 777X also have the advantage of lighter-weight, composite structures. “There is some risk [the A380] becomes the last metal albatross if you want to keep it in production for so many years,” Hamlin says.

For months, Airbus has been preaching patience on the timing for a final decision. It is currently focused on testing the A320neo family and developing the A350-1000 and re-engined A330neo family. Any move to similarly upgrade the A380 would fall at the back

of that queue, which extends through the end of the decade. That is also around the time that Emirates’ performance requirements, Rolls-Royce’s engine roadmap and Airbus’ product strategy could converge.

“If one looks at the early 2020s, there may be a confluence of available engineering resources, better engine technology, falling A380 sales and increased 777X competition, which may well lead to an A380 neo,” says Chris Seymour, head of market analysis for Flightglobal Ascend.

Engine technology has already come far since the A380 arrived in service. Both the Engine Alliance GP7200 – featuring a high-spool derived from the GE90 and a low-spool adapted from the PW4000 – and the R-R Trent 900 represent the last application of propulsion technologies developed in the late-1990s.

“With more than half the final backlog invested in Emirates, their influence here is key”

ROB MORRIS

Head, Flightglobal’s Ascend consultancy

Although the Engine Alliance opened the public debate on A380 re-engining 15 months ago, the joint venture is no longer willing to launch a new clean-sheet engine project. GE is already consumed delivering its half of the CFM Leap engine family and the GE9X for the Boeing 777X.

“Others may have a different idea but for us I would be really remiss if I led you to believe we were interested in [an A380 re-engining programme],” GE Aviation chief executive David Joyce said last March.

R-R, indeed, has a different view driven by a long-range strategic need. The company has

outlined a design concept for an UltraFan engine that could be available by 2025, possibly featuring carbon/titanium (CTi) composite fan blades, a low-pressure section reduction gear and a variable area fan nozzle. That engine could help R-R achieve a new level of fuel efficiency beyond that of even the GE9X.

HALF-STEP

However, an intermediary step would help R-R bridge from the Trent XWB programme to the UltraFan. The company’s internal research and development programme – dubbed Advance – formed the basis of the company’s proposal to power the 777X, but it was rejected by Boeing. The re-engining programme for the A380 would offer an ideal half-step, allowing R-R, for example, to introduce the CTi fan blades on the Advance engine, then inserting more efficient variable pitch blades on the UltraFan.

The correlation of Emirates’ desire for more fuel efficient aircraft and R-R’s need for an application for the Advance projects has persuaded some analysts that the A380 re-engining programme is inevitable. Kevin Michaels, a senior consultant for ICF, argues that R-R is likely to pay most of the estimated \$2.5 billion development cost for such programme, which lowers the overall economic risk to Airbus.

It does not, however, remove the overall economic and strategic concerns over the concept. If order activity for the A380 does not pick up, Airbus faces the possibility of A380 production shutting down before a re-engined version becomes available.

“If not launched this year, [entry into service] probably wouldn’t be until 2021. With no orders except Middle Eastern carriers, production might end before then,” says Richard Evans, senior consultant at Flightglobal Ascend. ■



Emirates, by far Airbus’s biggest A380 customer, is keen on a re-engining programme

NEW-GENERATION NARROWBODIES

Stepping up a gear

Pratt & Whitney is pulling out all the stops in its effort to get ahead of rival CFM International in the competition to power A320neos

STEPHEN TRIMBLE WASHINGTON DC

In a little over four years, Airbus has signed firm orders for more than 3,600 A320neo family aircraft. Forty percent of those tail numbers – representing an astounding roughly 1,450 aircraft – remain up for grabs in the competitive engine duel between CFM International and Pratt & Whitney.

So far, CFM has claimed the early advantage in the competition with 33% of the declared engine selections, compared with 28% for P&W, but the lead position could still change several times as the first A320neo – powered by two PW1100G-JM engines – enters service later this year. A selection by a single carrier – Lion Air, for example – to power all 174 unclaimed A320neo aircraft could pull P&W within a percentage point of CFM's lead. Alternatively, it could push CFM's numerical strength even further ahead.

That competitive dynamic has set the stage for some aggressive manoeuvring by P&W over the past year. In two key announcements since last May, P&W has shown a new assertiveness that has changed the orders race and empowered Airbus to launch a strategically important new version of the A321neo a year ahead of the scheduled entry into service of the first major variant of the re-engined aircraft family.

ACCELERATION

Historically, P&W's aggressiveness this early in an engine production programme is unprecedented. The PW1100G-JM engine family succeeds the International Aero Engines V2500 engine originally developed by a joint venture led by P&W and Rolls-Royce. P&W now controls V2500 production and PW1100G-JM production, and it is moving with a speed on the latter that was never attempted on the current A320 design.

The V2500 entered production in 1989, and the first major performance improvement package dedicated to improving specific fuel consumption did not appear until 16 years later.

By contrast, the PW1100G-JM will not enter production until Airbus delivers the first A320neo in the fourth quarter. But already P&W has promised to deliver a performance improvement package in 2019 with a



Pratt & Whitney promises to reduce the PW1100G-JM's specific fuel consumption by 2%

2% reduction in specific fuel consumption relative to the entry-into-service target. "One major distinction is that this is an additional fuel reduction beyond our initial commitment to Airbus and not a fuel recovery package or PIP due to a shortfall," P&W says in a statement to Flightglobal.

Moreover, the thrust range of the PW1100G-JM design has expanded at a remarkably faster pace than the V2500's. It took two decades for IAE to launch a 35,000lb (156kN)-thrust version of the V2500. A pair of 35,000lb-thrust V2500-E5s are powering the Embraer KC-390 now in certification flight testing. By contrast, P&W has already launched a 35,000lb-thrust version of the PW1100G-JM, stretching the engine's thrust range within a few years of entry into service from 24,000lb-thrust to 35,000lb-thrust. It also adds 8% more thrust to the next-largest version of the PW1100G-JM – a 33,000lb-thrust model developed to power the A321neo and a similar design that will be installed on the Irkut MC-21.

Those two developments – better fuel efficiency and more thrust – enabled Airbus to

launch a long-range version of the A321neo last January, with the goal of replacing winglet-equipped Boeing 757-200s flying transatlantic routes beyond the range of the baseline A321neo and the 737 Max 9.

"This [improvement package includes] an additional fuel reduction beyond our initial commitment to Airbus"

PRATT & WHITNEY

So far, CFM has not offered an answer to P&W's promised fuel efficiency improvement and thrust increase, but that could only be a matter of timing. The CFM development programme for the Leap-1A engine trails the schedule for the PW1100G-JM by roughly nine months. P&W also has benefited from its experience developing and certifying the similar PW1500G engine for the Bombardier CSeries, which was originally supposed to enter service two years ahead of the A320neo but now is scheduled to be delivered in the second half of this year.

DECISIONS

So far, little is known about how the PW1100G-JM will be modified to achieve the promised reduction in specific fuel consumption. The first engine built at the improved standard is now scheduled for introduction in 2019, with full production ramp-up achieved by 2021, P&W says. Over the next three years, P&W will be making a series of design decisions.



P&W is currently losing the A320neo race



The engine is set for aerodynamic upgrades

» “There is a full suite of technologies in the design phase that will make up the PurePower Advantage package,” P&W says.

“As we complete the design and test process, the specific modifications will be selected as part of the Advantage package. This will include a combination of aerodynamic enhancements along with coating and cooling modifications.”

“A full suite of technologies in the design phase...will make up the PurePower Advantage package”

PRATT & WHITNEY

Those coating and cooling modifications suggest that P&W engineers have discovered the engine core of the PW1100G-JM is more robust than originally expected. If the compressor section can be tuned to increase the pressure of the air flow entering the combustion chamber, the coatings and coolings on the turbine components aft of the combustor will need to be improved.

The soaring order backlogs for both the A320neo and the 737 Max – approaching 6,300 firm orders in total – mean there is ample business for both engine types in de-

TECHNOLOGY MICHAEL GUBISCH MUNICH

MTU GETS TO CORE OF P&W WIDEBODY TURBOFAN

Subassembly manufacturer MTU is planning to develop engine core technology for a yet-to-be-launched widebody version of Pratt & Whitney's PW1000G geared turbofan.

The Munich-based company is supplying part of the high-pressure compressor and the entire low-pressure turbine for the PW1000G series, different versions of which have been selected to power a range of narrowbody and regional aircraft, spanning the in-development Airbus A320neo, Bombardier CSeries, second-generation Embraer E-Jet family, Irkut MC-21 and Mitsubishi Aircraft MRJ.

Expanding the engine's architecture to the widebody segment will require a redesign of the core, including an enlarged HP compressor with additional stages, says MTU operating chief Rainer Martens.

The development team will explore new materials and improved component cooling to accommodate higher temperatures and pressures in the core, he says.

Pratt & Whitney has arguably concentrated primarily on boosting aerodynamic efficiency through the geared turbofan architecture for the engine family's first generation, but the manufacturer is aiming to achieve higher thermal effi-



Operating chief Martens is looking to the future

ciency through new core technology for the next generation.

The PW1000G features a reduction gearbox on the shaft connecting the fan with the LP turbine to optimise the rotational speeds of both sections for higher fuel efficiency. This

allows the fan to spin a slower speed than the LP turbine.

Martens suggests that a potential widebody version could be available between 2025 and 2030. The development of a new engine type typically takes around five years between programme launch and service entry, he says. But that assumes the required technology being readily available. Developing such technology to a stage where it can be employed usually adds another five to 10 years to the programme timescale, he indicates.

MTU holds a share of between 15% and 18% in the PW1000G programme, depending on engine model, and could seek a similar stake on follow-up programmes. ■



The PW1000G series is set to be adapted for widebodies



First flight of the A320neo was undertaken using Pratt & Whitney's PW1100G-JM engine

velopment. However, CFM's sole-source position on the 737 Max and current lead on the A320neo provide an incentive for P&W to move aggressively. In addition to the Airbus application, P&W may be able to spread the improvements to other aircraft.

In recent months, Russian industry officials have discussed the need to reduce reliance on Western suppliers for locally designed aircraft. However, the first Irkut MC-21 is still expected to fly in 2016 with PW1400G engines, which are scheduled to achieve certification later this year.

P&W says it is “carefully monitoring” geopolitical developments in Russia, but “meeting our commitments both to Irkut for the MC-21 programme and to our airline customers is of critical importance to us”. ■

COVER STORY

Printing revolution

Rolls-Royce plans to fly the biggest engine part made by 3D printing techniques. What does it mean for manufacturing?

MURDO MORRISON DERBY

Contained within the vast complexity of a modern widebody jet engine it may look like just another large, intricately designed metal structure. But a 1.5m-diameter titanium front bearing housing (FBH) inside a Rolls-Royce Trent XWB-97 engine is a structure with a difference. It could point the way to an eventual revolution in aerospace manufacturing, changing everything from the way factory floors look to the speed at which new components, prototypes and programmes are developed.

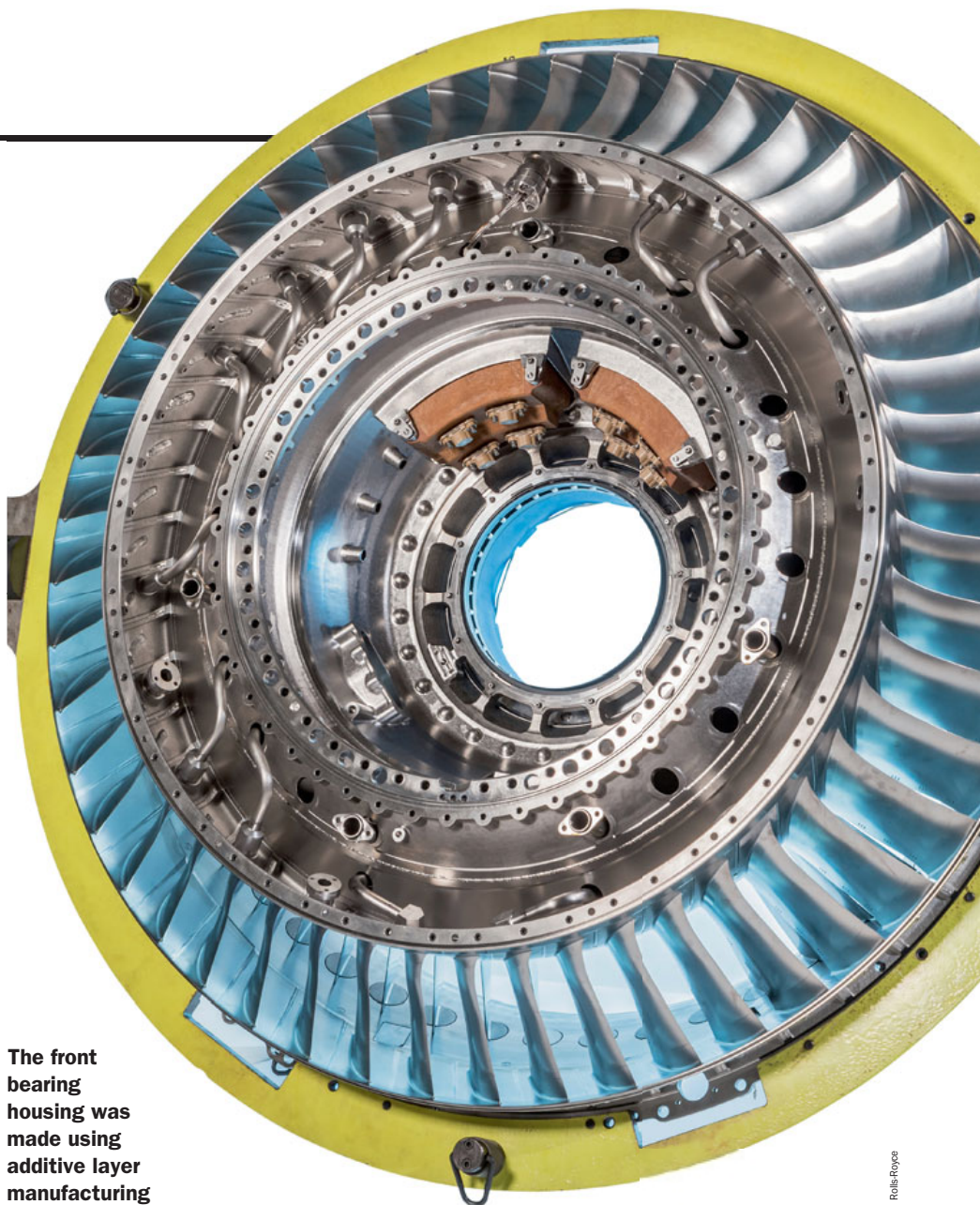
The FBH, which holds the bearings for the low- and intermediate-pressure compressors, has been constructed almost entirely of components produced by additive layer manufacturing (ALM), also known as 3D printing. When an XWB-97 containing the part takes off on an Airbus A380 flying test-bed later this year, it will be the first time that such a large engine component made using ALM techniques will have been airborne.

ALM has been one of the biggest talking points in aerostructures in recent years, and, while not all are convinced, many believe it could eventually have as significant an impact on the industry as composites. Over the past few years, R-R's arch US rival General Electric has pioneered the technique in terms of manufacturing, and R-R itself has used ALM to carry out small-scale repairs for almost a decade.

However, while others have been introducing very small ALM elements to their products, R-R has been determined to test the ability of engineers to build a large, complex structure capable of forming part of a working engine. The housing has already been ground-tested in a Trent XWB-97, the exclusive engine for the Airbus A350-1000, several times in recent months, and R-R says it is now ready to fly.

BUILDING

ALM is a technique by which metal powder is melted by a programmed electron beam, and exactly, micro-thin layer by layer, constructed into complex shapes. It has mostly been used in the industry to construct smaller parts, perhaps up to the size of



The front bearing housing was made using additive layer manufacturing

a fist. However, Rolls-Royce has been using expertise gained from the repair world to “build up to bigger components”, says Alan Newby, chief engineer, future programmes and technology.

“It is one of a number of technologies critical to our future competitiveness,” he says. “We are moving very quickly and the technology has a lot of potential moving forward.” So, other than the novelty of creating a sophisticated and robust piece of machinery from what is effectively metal dust, why is ALM such a big deal? There are two reasons close to the heart of any development engineer (or, indeed, financial director): cost and speed of manufacture.

In terms of cost, the crucial element is that waste is reduced. Rather than shaving a piece

“It is one of a number of technologies critical to our future competitiveness”

ALAN NEWBY

Chief engineer, future programmes and technology, R-R

of metal into the shape required – the traditional method of machine tooling – a part is layered from the ground up. “You don’t hack off metal,” explains Newby. “You more or less go straight to the finished article.” Related to this is the speed at which newly designed parts can be constructed – using ALM techniques can trim 30% from “like for like manufacturing lead time”.

This makes it ideal for prototyping, says Newby, as new tooling does not have to be designed and programmed. “Shortening the manufacturing time by almost a third gives us more time to design, which is always a benefit,” he says. Because Rolls-Royce is not “bound by constraints of traditional manufacturing methods”, he adds, “we are also able to produce designs that we wouldn’t otherwise be able to do”.

Although the ALM component will fly in a Trent XWB engine shortly, do not expect to see it or similarly manufactured parts in the first Trent XWB-97s off the production line. It will take a while, says Newby, for the technology to be industrialised. How long that is

» likely to be, he will not be drawn on. “We don’t want to put a date on it. We have a lot of work to do on scalability before making a commitment to production,” he says.

Neither is ALM so revolutionary that one day soon all aircraft and their individual parts will be built this way, believes Newby. For a start, the process obviously does not work for composite materials, and even for metallic parts the jury is still out. “It’s not suitable for all components and you’ve got to make sure you pick the right ones. We are going through an exercise now to see what components would benefit,” he says.

On the other side of the Atlantic, GE has been grabbing many of the headlines when it comes to ALM. It bought family firm, and Cincinnati neighbour, Morris Technologies in 2012, a pioneer in ALM techniques since the very early days of the technology in the mid-1990s. Factories in Alabama and Italy will



3D printing techniques can reduce waste

produce ALM components for CFM International Leap engine that will power Boeing 737 Max and Airbus A320neo aircraft, as well as the GE9X for the Boeing 777X.

TEAMWORK

Like GE, Rolls-Royce has bought in outside expertise to develop its ALM techniques. The housing in the Trent XWB has been designed with specialists from the UK’s University of Sheffield and the Manufacturing Technology Centre in Coventry – an institution founded in 2010 to bring together industrial players such as Rolls-Royce, Airbus and Unilever and academic researchers – as well as Swedish firm Arcam, which makes additive manufacturing equipment.

Over the past two years, the Derby propulsion maker – which has a dominant position with Airbus and competes with GE’s GENx on the Boeing 787 – has been keen to project an

DEVELOPMENT MURDO MORRISON DERBY

ROLLS-ROYCE AIMS FOR PERFECT TEN

ROLLS-ROYCE expects to hit key milestones for its big two in-development engine variants this year, with first flight of the Airbus A350-1000’s Trent XWB-97 on a flying testbed expected in the third quarter and certification of the Trent 1000-TEN for the Boeing 787 earmarked for November.

A third new programme – the Trent 7000 for the new Airbus A330neo – will begin ground testing

this year, too, ahead of flight testing in 2016. The 72,000lb (320kN) powerplant is based on the Trent 1000-TEN. Both aircraft and engine were announced at Farnborough last year.

R-R expects the TEN to enter service in the second half of next year. The name originally caused some confusion, suggesting it was a version of the Trent 1000 for the in-development 787-10. Instead, it

stands for “Thrust, Efficiency and New technology” and will be available for all three 787 variants. R-R plans to have transitioned all its Trent 1000 production to the TEN by 2017, in time for the entry into service of the third and largest version of the 787.

Although General Electric’s GENx has a market share advantage in 787 orders and deliveries of almost three to two, R-R believes it has mo-

mentum on its side. “We have 49% of operators and, out of the last 18 order competitions, we have won 12,” says Gary Moore, Trent 1000 project director. The UK company also has bragging rights in terms of powering the first 787-8 and 787-9 in service.

DERISKING

The TEN adopts technology from the Trent XWB not found in earlier versions of the Trent 1000, including the A350 engine’s compressor and extra stages of blisk, as well as a new high-pressure turbine architecture. The advantage of this work, says Moore, is that “it derisks the programme for Boeing” when it comes to putting the 787-10 into service. “They are not going to have to put a new engine on a new programme.”

Testing on the TEN continues, with flight testing on a Boeing 747 flying testbed due to begin at Arnold air base in Tennessee in a few months “to demonstrate that everything we’ve learned at sea level works at altitude”, says Moore.

“Boeing are not going to have to put a new engine on a new programme”

GARY MOORE

Trent 1000 programme director, R-R



Rolls-Royce expects to be building one Trent XWB-97 a month by the end of this year

"Shortening the manufacturing time by almost a third gives us more time to design"

ALAN NEWBY

Chief engineer, future programmes and technology, R-R

image as an innovator. Last year it revealed two future widebody engine studies – the Advance and UltraFan – containing a range of potential new technologies, including composite fan blades, lower-emission combustion systems and, for the first time on a widebody engine, a gearbox.

Despite pulling out of the narrowbody market three years ago after it abandoned the Pratt & Whitney-led International Aero Engines consortium, and losing most of its ground in the business aviation market to rivals, Rolls-Royce has also said it wants to get back into the single-

aisle market in the next decade. However, to do this it will need to come up with a technology that leapfrogs the latest-generation offerings from incumbents CFM and Pratt & Whitney.

Newby says his job is simply to "deliver the business options" to his superiors in Rolls-Royce, whether that is by using ALM, more efficient widebody engines, a new narrowbody engine design or more radical "potential disruptors" such as electrical-powered fans. With ALM, he admits that part of the challenge is "changing the mindset of engineers" used to working with conventional methods such as forging and casting.

However, ALM opens the possibility of greater innovation because experimental prototypes can be designed and trialled quickly in a way that just would not be practical using traditional methods. Newby believes the technology is just in its infancy in terms of its potential. "We are just scratching the surface," he says. ■

R-R insists the TEN will deliver 2% additional fuel economy over the current "package C" engine introduced in the middle of last year. That version was an upgrade of the original "package B" on the original 787-8s. Operators with the earlier variants will be able to replace their older engines, and fly with a TEN and "package C" on either wing, says Moore.

Meanwhile, 10 months after delivery to Airbus of the first Trent XWB-84 engines for the A350-900, and eight months after its first engine run, its sibling, the -97, is well into its test schedule, with a third example on its way to Manitoba, Canada, to begin ice testing, and a fourth about to be powered up for the first time.

"We will deliver the first flying testbed engine in quarter two and it will fly – depending on Airbus of course – in quarter three," says Simon Burr, R-R's director of the Trent XWB programme. The largest version of the widebody is expected to fly – powered with Trent XWB engines – around summer next year, ahead of its entry into service in 2017.

By the end of this year, R-R expects to be building one Trent XWB-97 a month, and with "well



Rolls-Royce promises 2% fuel advantage on Trent 1000 TEN

over" 70-84s due to be delivered in 2015, production rates for both variants combined will have reached one a day. Both

the Trent XWB and the Trent 1000 are being built on pulsing production lines, a first for the engine maker. ■

TESTING

Peebles power

Deep in the Ohio countryside, General Electric's outdoor test centre is leading the way in proving new engine technologies

DOMINIC PERRY PEBBLES, OHIO

Drive west from Cincinnati along Ohio state highway 32 towards Virginia and the roads get progressively emptier. The further west you get, the deeper into Amish country you are: signs warn of the likelihood of encountering slow-moving buggies ahead. But every now and then flashing orange lights strobe along the oncoming carriageway as a huge tractor-trailer rig approaches, a wide load sign on its nose. In the well of each of these low-loader trailers is a tarpaulin-wrapped shape that despite the covers is unmistakably a large jet engine.

It is an utterly incongruous sight, hinting at the sort of high-tech manufacturing not generally associated with a part of the world where barn raising appears to be the biggest local industry. But off the main road, just past the town of Peebles, the reason why millions of dollars-worth of jet engines are being hauled around quickly becomes apparent.

MODERNISED

There, tucked away among 10 square miles of forest on a site that includes its own beaver dam and herds of wild deer, is engine manufacturer GE's test facility. It dates from the 1950s, when the company first used the site to experiment with different types of rocket fuel. A few traces of this era remain but by and large the site is now a picture of modernity.

Isolation is granted by the acres and acres of empty woodland, and the site sits within the airspace of nearby Rickenbacker AFB, deterring overflights. The overall impression is of a Bond villain's secret lair – it even has its own runway, albeit a decommissioned one.

GE has been expanding Peebles in recent years as it plans a virtually unprecedented ramp-up in production across its portfolio. In fact, says site leader Brian DeBruin, the company has invested some \$70 million in the facility over the past two years – and that excludes the earlier construction of an outdoor test rig for the now-cancelled F136 military engine for the Lockheed Martin F-35, which has been pressed into wider use. The recent spending round has included building two additional indoor test cells, accounting for \$40 million of that \$70 million expenditure. The last of these – test cell 5D – was handed over late in 2014, and the



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» final stages of calibration work were taking place during our visit in late January.

These huge, cathedral-like spaces are predominantly used for pre-delivery engine runs, and the investment in additional capacity speaks volumes about planned production increases. For instance, GE's CFM International joint venture with Snecma is expected to increase narrowbody engine production from around 1,500 current-generation CFM56Bs this year to 1,800 by 2019 – the majority of which will by then be the in-development Leap powerplant. As with the CFM56, many Leaps will be assembled by GE's French partner in Villaroche, but that leaves a substantial number – everything destined for Boeing's 737 line in Seattle, for a start – to be absorbed by Peebles. And that does not take into account the increased production of the GENx-1B required for the 787, continued high rates on the GE90 for the 777 and, towards the end of the decade, the arrival of the GE9X for the 777X.

Final assembly of all the large powerplants takes place at Peebles, and that part of the facility is growing too, with an additional load-out bay – where the complete engines, plus test nacelles, pylons, inlets and its test frame are transferred onto the back of a truck – currently under construction. When finished there will be a bay for each of the widebody engine models assembled at the site. Once aboard the tractor-trailer, the engines, now weighing in at double their bare weight of 7.5t apiece, are painstakingly low-gear-hauled up what GE refers to as “the hill”.

PASSPORT CHECKS

This is where the seven outdoor test stands are located. Presently they are pretty busy. At least three spaces are occupied by GE's new Passport business jet engine, as technicians prepare for blade-out, water ingestion, and crosswind tests – the latter carried out using a rig that can create a 50kt gale at right-angles to the engine. “We can get it so that no matter the position of the aircraft we can check that the engine behaves in all flight characteristics. It has to be outside the curve that it could ever fly in,” says DeBruin.

A pair of the new Leap engines – a -1A for the Airbus A320neo and a -1B to power the 737 Max – are also on stands as the programme accelerates towards planned certification next year. Peebles has played a key part in that process, having performed the pre-flight trials of the two engines – a -1C and -1A – currently being used in the flight-test campaign in Victorville, California.

Alongside the investment in site infrastructure, GE has also been increasing personnel, with 70 new staff members added over the last two years. This takes total numbers at the facility to around 350 direct employees, plus an additional 150 contractors. With the anticipated



Inside a turbulence stability test dome

“We’ve spent a lot of effort on being ready and have the right capability and resources”

BRIAN DEBRUIN

Site leader, GE's Peebles facility

ramp-up in activity, the recruitment push has been vital. “We’ve spent a lot of effort on being ready and have the right capability and resources because we know that we don’t have the time to lollygag,” says DeBruin.

GE's investment in Peebles is part of a broader expansion across the whole of its aero engines business. This has included acquisitions, such as the 2012 purchase of Cincinnati-based Morris Technologies and 2014's capture of Avio Aero in Italy, as well as the opening of new factories to support the engine ramp-up. Of course, those two takeovers were not simply about obtaining additional capacity, but also increased GE's manufacturing capabilities.

Much has been written about the additive layer manufacturing (ALM) processes championed and honed by Morris – and Avio to a

lesser degree – but they form an important part of the jigsaw. Aside from the rapid prototyping now available, techniques developed by Morris – now rebranded as GE's Additive Development Center – are to be used to produce components on several engines, notably low-pressure turbine blades on the GE9X and fuel nozzle tips on the Leap series.

EFFICIENCY

ALM is quicker than subtractive manufacturing techniques and allows the creation of structures that could not be realised with older technology. To put it another way: if you can print the part from the ground up, you can create all kinds of clever internal structures that would be impossible to machine.

GE plans to produce the ALM nozzles at a new facility in Auburn, Alabama, which is due to open by the middle of this year. Capacity will be around 30,000 initially, rising to 100,000 by 2020. And although the materials used in ALM are not yet ready to be applied to high-pressure turbine blades, where single-crystal forgings are desired, the rapid production cycle it permits has helped GE's engineers to revise the unique internal cooling structure of the next-generation components, says Mike Cloran, the Additive Development Center's marketing manager. These will feature on the Leap powerplants, with a more advanced iteration to feature on the GE9X.

What may not be possible now could become viable in the future as the technology matures, Cloran says. “Forging has been around for hundreds of years, machining and casting have been around forever, [ALM] has only been around for 10 years.

“It is going to look very different in the future. What we can do today is only a fraction of what we will be doing in 10 or 25 years.” ■



Dust ingestion testing is carried out at Peebles

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Maintain altitude and talk about it

As a former aviator I have the utmost sympathy for pilots who make cognitive errors when faced with an engine failure on take-off (such as stamping on the wrong rudder or shutting down the wrong engine – especially if the wrong engine was a bit suspect recently).

I have no such feelings for a crew that lose IAS [indicated air speed] in the cruise and don't just maintain attitude and power while saying to each other: "Well we have five hours to talk about how we are going to land this thing."

John Farley

By email

F-35 ski-jump

I found your article "Greased lightning" on the Lockheed Martin F-35 (*Flight International*, 27 January-2 February) to be most informative.

However, it did not mention whether the F-35B has yet been tested taking off using a ski-jump, as featured on the UK's new aircraft carriers.

DISAPPEARANCE

Eyewitnesses to MH370

Given the recent article on the likely path followed by MH370 (*Flight International*, 13-19 January), it might be an idea to look again at eyewitness reports. Of numerous claimed sightings, it seems only one could be consistent with the ACARS data.

A sailor reported an aircraft flying north to south, northwest of the tip of Sumatra, around 03:00 local time. The aircraft was described as glowing orange, but with no visible light sources or windows. It was trailing smoke, appeared "long and pointy", and was flying slowly well below the altitude of two other aircraft heading in the opposite direction.

If this was MH370, the strange glow, perceived shape, and low altitude and speed of the aircraft could be the result of a fire that had ruptured the sidewall. Light emitted by the fire would reflect from the engine nacelle and illuminate the lower arc of the fuselage.

Some believe the crew turned MH370 westwards at about 01:25 in order to gain the nearest long runway. However, an hour later, a night-time landing would have been problematic with a continuing fire, unused fuel, and no lights or communications.

Perhaps the crew, faced with multiple system failures, darkness, smoke, hypoxia, and stress, opted to keep the coast of Sumatra in sight and await daylight.

If the aircraft flew slowly, and on an erratic course, the ACARS data would suggest it came down well to the northeast of current search locations.

More possibilities may need to be explored if this mystery is to be resolved.

Richard Lloyd

Coventry, UK

I would be most interested to know if such tests have yet been conducted – they would have to have been conducted on a land-based test rig.

Peter Martin

Beacon Hill, UK

Editor's reply: Testing of the F-35B using a shore-based ski-jump ramp will be conducted by the UK at NAS Patuxent River in Maryland. The required structure has already been built, but not yet used.

Augustine's Laws

In his piece on the "sixth-generation" fighter initiative (*Flight International*, 10-16 February) Dan Parsons wrote:

"The new approach also breaks with past efforts, such as the Lockheed Martin F-22 Raptor and F-35 Lightning II. Each began with lofty technological promises from industry, but then struggled due to cost overruns and developmental delays, which in the case of the Raptor resulted in a significant downsizing of the planned fleet size" – a sentiment repeated in the caption to the photo of a formation of F-22s.

I suggest that Dan studies *Augustine's Laws* (published by AIAA), in particular the original 1987 edition.

Many of the long-term historical trends laid down in this work have continued since

1987. A careful examination in particular of laws VIII and IX, and the linkage between them which, perhaps surprisingly, was not explored by Augustine, will show that, even at targeted cost levels, the F-22 was never going to be acquired in anything like the numbers originally specified.

Cost overruns and schedule delays may well have exacerbated the reductions in planned F-22 fleet size but they were most certainly not the primary cause of these reductions. It is to be hoped that those studying "sixth-generation" developments are aware of these continuing pressures and their full implications.

Peter Liddell

Lytham St Annes, UK

Female victim

Regarding your story "F-16D crash kills 11 at Spanish NATO exercise" (*Flight International*, 3-9 February): to put the record straight, one of the French victims was a female lieutenant, Marjorie Kocher, a navigator who took part in operations in Afghanistan, Libya and Mali.

Bernard Gloux

Stavanger, Norway

Editor's reply: Our apologies.

We referred to a "two-man crew". Thank you for clarifying.

Mangling English

Your mangling of the English language may be considered smart by you and your columnists, but continues your pathetic and childish aping of transatlantic "English". Witness: inking contracts, uptick and other meaningless phrases.

Who do you think you are impressing? Please return to standard English.

BJ Mulady

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10-11 May

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13-14 May

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17-20 May

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19-21 May

EBACE
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26-28 May

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31 May - 3 June

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4-6 June

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franceairexpo.com

15-21 June

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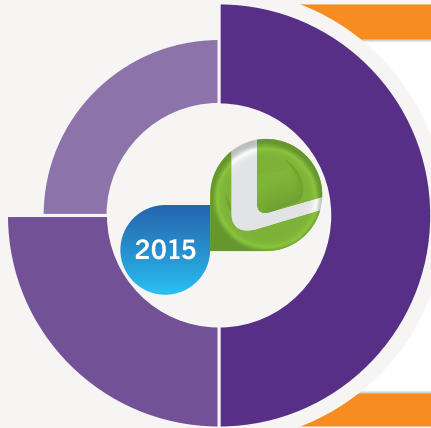
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PHONE: 8901600-14, 8901680-94, FAX: 88-02-8901558, www.biman-airlines.com
Ref: DACPM/777-200ER/153/2015/1455 Date: 19 February 2015

Request for Proposal (RFP) for Dry Lease of one 777-200ER Aircraft

1. Biman Bangladesh Airlines Ltd. invites offers/proposals for Dry Lease of 01 (one) 777-200ER aircraft for a period of 60 (sixty) months. Airlines, Operators, Owners of Aircraft, Manufacturers, Leasing Companies having aircraft of its own or legally authorized by the owner to submit the offer, may participate in the RFP complying with the terms & conditions stated in the RFP schedule. Basic requirements are mentioned below:

i. Number and Type of Aircraft	01 (one) 777-200ER aircraft powered by PW4090 engine
ii. Nature & Period of Lease	Dry Lease for 60 (sixty) months.
iii. Configuration	Two class standard configuration not less than 319 seats. All seats shall have to be in good condition.
iv. Age of the Aircraft	The aircraft should not be more than 10 years of age as on closing date of RFP.
v. Authorization	If the Lessor is not owner of the aircraft, owner's authorization/mandate must be submitted prior to negotiation
vi. Commencement of Lease	July 2015

2. Detailed terms and conditions have been given in the RFP schedule. RFP notice and schedule may be viewed in Biman's web-site: www.biman-airlines.com .
3. The Offers/Proposals are to be submitted latest by 1000 hours LT (0400 hrs UTC) 15 March 2015 addressed to General Manager (Corporate Planning), Biman Bangladesh Airlines Ltd., Head Office, Balaka, Dhaka, Bangladesh through E-mail at dacpm153@bdbiman.com. Proposals/offers may also be submitted through courier service or dropped in the Tender Box placed in the office of General Manager (Corporate Planning), Biman Head Office, Balaka, Kurmitola, Dhaka-1229. No offer/proposal will be accepted after the closing time and date.
4. For further information or query, General Manager (Corporate Planning) may be contacted at Telephone: +880-2-8901600/Extension-2415, +880-2-8901697 (direct), Fax: +880-2-8901396, E-mail: gmp@bdbiman.com during the office hours.
5. Biman Bangladesh Airlines Ltd. reserves the right to accept or reject any or all the offers/proposals partly or wholly without assigning any reason whatsoever and no claim shall be entertained in this regard.

Mohd. Abdur Rahman Faruky
General Manager Corporate Planning (Acting)



HEAD OFFICE, BALAKA, KURMITOLA, DHAKA-1229, BANGLADESH
PHONE: 8901600-14, 8901680-94, FAX: 88-02-8901558, www.biman-airlines.com
Ref: DACPM/737-800/154/2015/1456 Date: 19 February 2015

Request for Proposal (RFP) for dry lease of one 737-800 aircraft

1. Biman Bangladesh Airlines Ltd. invites Proposal/Offer for taking of 01 (one) 737-800 aircraft for a period of 60 (sixty) months on dry lease basis. Airlines, Operators, Owners of Aircraft, Manufacturers, Leasing Companies having aircraft of its own or legally authorized by the owner may participate in the RFP complying with the terms & conditions given in the RFP Schedule. Basic requirements are mentioned below:

a. Number and Type of Aircraft	01 (one) 737-800 aircraft.
b. Seat Configuration	Two class configuration with 162 (12J+150Y) seats. All seats shall have to be in good condition.
c. Age of the Aircraft	The aircraft should not be more than 10 years of age as on closing date of RFP.
d. Nature and period of Lease	Dry Lease for a period of 60 (sixty) months.
e. Commencement of Lease	July 2015.
f. Representation & Authorization	If the Bidder/Lessor is not the owner of the aircraft, then owner's authorization/ mandate must be submitted prior to negotiation.

2. Detailed information is available in the RFP Schedule. RFP Notice and Schedule may be viewed at Biman's website: www.biman-airlines.com .
3. The Proposal/Offer may be submitted to the General Manager (Corporate Planning) at E-mail: dacpm154@bdbiman.com by 1000 hours LT (0400 hrs UTC) on 16 March 2015. Proposal/Offer may also be submitted through Courier Service or dropped in the Box placed in the Office of the General Manager (Corporate Planning), Biman Head Office, Balaka, Kurmitola, Dhaka-1229 within the stipulated time. The Proposal(s)/Offer(s) will be opened immediately after the closing time in presence of the Bidder(s), if any. No Proposal/Offer would be accepted after the closing time. Biman Bangladesh Airlines Ltd. will not be responsible for late receipt of Proposal/Offer due to any reason, whatsoever.
4. For further information or query, General Manager (Corporate Planning) may be contacted at Telephone: +880-2-8901600/Extension-2415, +880-2-8901697 (direct), Fax: +880-2-8901396, E-mail: gmp@bdbiman.com during the office hours.
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PHONE: 8901600-14, 8901680-94, FAX: 88-02-8901558, www.biman-airlines.com
Ref: DACPM/777-300ER/155/2015/1461 Date: 24 February 2015

Request for Proposal (RFP) for Dry Lease of one 777-300ER Aircraft

1. Biman Bangladesh Airlines Ltd. invites offers/proposals for Dry Lease of 01 (one) 777-300ER aircraft for a period of 60 (sixty) months. Airlines, Operators, Owners of Aircraft, Manufacturers, Leasing Companies having aircraft of its own or legally authorized by the owner to submit the offer, may participate in the RFP complying with the terms & conditions stated in the RFP schedule. Basic requirements are mentioned below:

i. Number and Type of Aircraft	01 (one) 777-300ER aircraft.
ii. Nature & Period of Lease	Dry Lease for 60 (sixty) months.
iii. Configuration	Two class configuration not less than 419 seats. All seats shall have to be in good condition.
iv. Age of the Aircraft	The aircraft should not be more than 10 years of age as on closing date of RFP.
v. Authorization	If the lessor is not the owner of the aircraft, owner's authorization/mandate must be submitted prior to negotiation.
vi. Commencement of Lease	July 2015

2. Detailed terms and conditions have been given in the RFP schedule. RFP notice and schedule may be viewed in Biman's web-site: www.biman-airlines.com .
3. The Offers/Proposals are to be submitted latest by 1000 hours LT (0400 hrs UTC) 19 March 2015 addressed to General Manager (Corporate Planning), Biman Bangladesh Airlines Ltd., Head Office, Balaka, Dhaka, Bangladesh through E-mail at dacpm155@bdbiman.com. Proposals/offers may also be submitted through courier service or dropped in the Tender Box placed in the office of General Manager (Corporate Planning), Biman Head Office, Balaka, Kurmitola, Dhaka-1229. No offer/proposal will be accepted after the closing time and date.
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Full details and further updates can be downloaded from NRSC website (<http://www.nrsc.gov.in/>) and ISRO website (<http://www.isro.gov.in/>).

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WORK EXPERIENCE CHRISTOPHER WATSON

Keeping a fleet off the ground

Christopher Watson is the commercial manager for the UK's largest business charter company, London Executive Aviation. His main responsibility is ensuring the company's aircraft are as busy as possible

Tell us about your career to date

I've always worked in aviation and knew I wanted to do so from a young age, so when the time came, I studied aircraft maintenance and engineering at college. From there I began my career as an apprentice with British Midland (now bmi), working on the maintenance and engineering of Airbus and Boeing aircraft. Unfortunately the apprenticeship scheme finished, so I moved to London City airport, where I worked in the aircraft ground handling department. I then progressed to airfield operations, where I was responsible for tasks such as airside safety and planning, runway inspections, liaising with air traffic control and airport management. After gaining some experience in what was London City's newly formed Jet Centre (a facility built to handle private jets), I joined London Executive Aviation (LEA) in 2005 as an operations controller, looking after all aspects of arranging a flight from start to finish. I've since worked my way up to be the commercial manager.

Have you always been interested in aviation?

I've been interested in aviation for as long as I can remember and like to stay up to date with the industry by reading as much about it as I can. I also gained my private pilot licence in Florida in 2004 but I don't really get to fly as much now due to a lack of time.

What does your job involve?

As commercial manager, I'm primarily responsible for making



Watson has been able to work in an industry he has genuine passion for

sure LEA's aircraft are flying as much as possible. It's about juggling schedules, maximising efficiency and ensuring there are as few empty leg flights as possible. It's also important that we meet our clients personally to ensure they are happy with their LEA experience. This means I regularly head out to airports such as London Luton, TAG Farnborough or London City to make sure everything is running smoothly.

What role do aircraft brokers play in your business?

For LEA they are very important. Most of our charter business – approximately 85% – comes through our aircraft brokers. I like to visit our brokers regularly; it's important to build strong relationships.

How is the business aircraft charter market faring?

It's quite difficult to judge at the

"It's about juggling schedules, maximising efficiency and ensuring there are as few empty leg flights as possible"

moment, as there doesn't appear to be a pattern emerging. I think there is still some uncertainty in the financial markets across the EU, although demand has improved over the last few years. I would like to see it increase as we go in to 2015.

What does your typical day involve?

There is no "typical day" at LEA. We handle around 200-250 quotes a day across our fleet and we like to respond to these as

quickly as possible. Throughout the week, I'll meet with LEA's cabin crew manager to discuss client requests and catering, our operations manager to check the crewing levels and with our maintenance manager to ensure that any upcoming scheduled maintenance is organised. I will also regularly update the managing director and chief executive on any developments in the industry or anything they need to be aware of within LEA on the commercial front.

What are the major challenges in your role as commercial manager?

Keeping the aircraft busy and flying! We have a large, diverse fleet, which we need to keep in the air. It's a challenge for any large operator but, as part of Lux-aviation Group, we have the support to address these challenges.

What do you enjoy most about your job?

I love working in an industry that I have a real interest in and passion for. Being commercial manager for one of Europe's largest private jet operators is a privilege; I enjoy representing the company and working with both brokers and clients. ■



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